GLS 9.0 CONFERENCE

JUNE 12-14, 2013 | MADISON, WI

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CONFERENCE PROCEEDINGS

Edited by : Caroline C. Williams, Amanda Ochsner, Jeremy Dietmeier, & Constance Steinkuehler

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GAMES + LEARNING + SOCIETY CONFERENCE

MADISON, WISCONSIN
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Games + Learning + Society Conference

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THE UNSUNG HEROES OF PL+GLS: AN OPEN LETTER

Running GLS is pretty killer--in that it rocks and is amazing and incredible, *and* in that it disembowels huge months of your life at a time, asking for every minute and every cognitive faculty at your disposal. The only reason that the first definition of “killer” outweighs the second is because of the volunteers--those gentle giants, those smiling faces, those tech-savvy (“yes, we can find you a dongle!”) and patient folks wearing blue and pink from 7 a.m. ‘til midnight every day for a week. You may not know about some of the extra gory details from the conference days, but there are a handful of people that went above and beyond their call, often in ways that were unnoticed, and sometimes even thankless. Ladies and gentlemen, this is to be no more! We publicly declare the awesomeness of the unsung.

This open letter is our way of doing so.

To Sean Seyler, who induced sanity and lucidity wherever he went, trekked to many a remote location to retrieve various suddenly needed items, and dispatched smoothly for his deeply grateful Day Captain, as well as coordinating all the social media and information bombs for the conference and the GLS Center. ALL WITH A BROKEN RIB. To you, we tip a gigantic glass full of that most delicious painkiller: friendship and local Wisconsin beer.

To Christian Schmieder, who: wins the award for *Kickass Volunteer Who Is Also Attending GLS For The First Time*; is the sole reason why we were able to pull off the online streaming and talk recordings; worked multiple dispatch shifts; and somehow also managed to take photographs--we cannot believe that we ever ran this conference without you. We tip our glass to you--and we’ll tip as many glasses as it’ll take to get you back next year!

To Sheng-peng Wu, who ran through the pouring rain and the sound of the tornado warning repeatedly Wednesday night, escorting people to the mysterious location of the art exhibit--and even walking folks to their hotel down the street--we tip our glass (and owe you a better umbrella).

To Jacob Henshaw, who a) is always a great volunteer and b) is the reason we had Oculus Rift available in the arcade this year, we tip our glass in memory of the extra-strange dimensions suddenly visible in *Portal*.

To Sam Graue-Landis, who has been an officially unofficial volunteer for years, and is always at the top of our “favorites” list, we tip our glass in memory of the years when you were around all the time instead of just the summer :/

To David McHugh and Kara Ripley, who volunteered at the last minute when other volunteers had to drop out, and hauled our figurative butts out of a couple literal fires (okay, maybe not *literal*, but it sure felt like it at the time!), we tip our glass of fire-retardant thankfulness.

To Alan Wolf, Christian Wilson, Mark Riechers, and Dan Kursevski, who all contributed to the photographing of Playful Learning and GLS: the conference always seems to go by at a blur--for adding persistent and beautiful clarity, we tip our glass gratefully.

To Jonathan Elmergreen, Rex Beaber, Amanda Barany, and Kyrie Caldwell, our ninja special event folks, we tip a gigantic and delicious glass of champagne. Or, you know what? We tip a BOTTLE of that stuff. ‘Cause you deserve it.

To Jason Matthias, one of our stalwart and delightful repeat volunteers: we tip a glass. (Although, frankly, after WINNING AN AWARD, these kudos are probably pretty unnecessary in the grand scheme of things. But we’re doing it anyway. So there.)

To Ryan Martinez and Shannon Harris, who managed all the things... The things with screens, the things with cords, the things with consoles, and the things with couch cushions. The arcade was awesome, fun, glorious, and multi-dimensional (see previous Oculus Rift reference). We tip our glass to you, but not so much that it falls and shatters the glass, like those TV screens did during shipping.

To Mark Riechers, who co-curated the Games & Art Exhibit, took photos, and kept our blood pressure down with his calm aura, we tip our glass. We’re glad your move went smoothly, and hope your new Chicago life is swell--

BUT WE MISS YOU. Jerk.

To Arnold Martin, who co-curated the Games & Art Exhibit and worked on the design and 3D printing team for the awards, we tip our glass. (Frankly, we're not sure how you managed to do all this from California. Also, we miss you.)

To Jordan Thevenow-Harrison, who was involuntarily on duty through successive 16-hour days, we tip a glass of "*Sorry*." You can be a "normal" volunteer when you stop being awesome.

Last, but certainly not least:

To Rex Beaber, who was the Day Captain for inaugural GLS Playful Learning Summit (as well as GLS special event coordinator), we tip our glass. Rex, as the first PL Day Captain, you set the bar really high--we quake sympathetically in our boots for anyone that has to follow your act.

To Amanda Ochsner, who was Day Captain the first day of GLS and brilliantly handled the "first day of the conference OMG!111" crises that always come up, we tip our glass. Thanks to Amanda (and her sergeant, Jeremy Dietmeier), these proceedings exist in all their epic awesomeness!

To Gabriella (Gabby) Anton, who balanced running the poster session, her first year as Day Captain, and presenting original intellectual work brilliantly, we tip our glass. (And wish that everyone had cool hair like you. You win the GLS 9.0 Delightful Hair award.)

And to Meagan "Perfect" Rothschild, who organized all the volunteers in advance AND--as Day Captain the second day--strong-armed her day into running perfectly, AND managed to present intellectually original work each day of the conference, we tip our "Congratulations on getting that new and real and awesome job right before GLS--and thank you for not abandoning us when you did" glass.

Sincerely, and with deeply abiding gratefulness and love,

Caro Williams

GLS 9.0 Executive Board

GLS 9.0 Conference Committee

PS: Benjamin Tarsa, you and your chef better come back and volunteer next year. We mean it. =D

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(*Who have earned our undying gratitude)*

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GLS 9.0 Award Winners

Three of our brilliant GLS-ers (Matthew Berland, Don Davis, and Arnold Martin) designed and 3D-printed the seven awards given away this year. In order of event, the award winners are:

Playful Learning (chaired by Remi Holden)

Playful learning gives the inaugural *Playful Learning Award* **to Jim Mathews**. He's a designer, a visionary, and an amazing classroom teacher–we're oh-so-lucky to have you leading the way, Jim!

Poster Session (chaired by Gabriella Anton):
The People's Choice Award goes to **Jayne C. Lammers and Victoria Van Voorhis for** *Gaming Bloom's: Deconstructing the Revised Taxonomy for Games-Based Learning.* The Judge's Choice Award goes to **Jeff Holmes, Rebecca Hoffman, Ben Pincus, Alex Cope, Jesse Shedd, and Tenneille Choi** for *Visual Analysis Toolkit: 5 Use Cases.*

Art Session (curated by Arnold Martin and Mark Riechers):
The People's Choice Award goes to **James Earl Cox III** for *Don't Kill the Cow.*
The Judge's Choice Award goes to **Steven Hilyard** for *One Life.*

Educational Game Arcade (chaired by Wade Berger)
The People's Choice Award goes to **Jason Mathias** for *Covalence: An Organic Chemistry Puzzle Game.* The Judge's Choice Award goes to **Kevin Miklasz** for *The Fluid Ether* **(formerly known as** *The World of Physics*).

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LONG PAPERS

Fireside Chats

Building the next science generation through game-based learning in museums

Audrey Aronowsky, Beth Sanzenbacher, Beth Crownover, The Field Museum
Barry Joseph, Preeti Gupta, American Museum of Natural History
aaronowsky@fieldmuseum.org, bsanzenbacher@fieldmuseum.org, bjoseph@amnh.org, pgupta@amnh.org, bcrownover@fieldmuseum.org

Abstract: In this chat, the American Museum of Natural History and The Field Museum highlighted different approaches to use museum-centered games-based learning programs to build a science-positive generation. The case studies cross a spectrum of technologies and museum goals, and speak to the diversity of techniques being used. Case studies were used to introduce broader questions about gaming and museum-based learning, such as: 1) Do games-based learning opportunities need to be centered in a museum's physical space? 2) How can museums use games-based learning to help youth develop a lifelong interest in science? 3) What are best practices for engaging youth and teens through games with museum collections? 4) What role can museums play in advancing games-based learning? Discussion themes included the importance of authenticity for engagement, the importance of games-based approaches for changing youth attitudes about museums, and the challenges and opportunities that museum collections present as source material.

Introduction

Within the field of education, it is well known that youth in the United States underperform in STEM and significantly trail their counterparts abroad with regard to STEM-related competencies. For example, in 2009, only 34% of 4th graders, 30% of 8th graders, and 21% of 12th graders performed at or above the proficient level in science (National Science Board, 2012). In order to address these shortcomings in STEM education, learning must not be limited to facts. Learners need to have an appreciation for science and to use science skills, such as problem-solving and critical thinking, to become educated consumers of science in both formal and informal learning spaces. This will make it more likely that they will be able to relate science to their everyday lives throughout their careers (National Research Council, 2012). Numerous studies have shown that providing opportunities for young people to participate in the scientific process is critical to their future enjoyment of and engagement with science (Lederman, 1992; Gibson and Chase, 2002). Despite these recommendations, the scientific process still largely remains inaccessible for youth.

Because of the way science is taught and presented, science is often perceived as a collection of obscure facts that are unrelated to daily life: science is not seen as a dynamic activity. However, at its most basic, science entails asking questions and making observations, two activities that youth practice regularly, if unknowingly, in both their daily and digital lives. Informal learning institutions such as zoos, aquaria, botanic gardens, and museums are particularly well-positioned to impact STEM learning, in part because they are not schools and are not burdened by the same preconceptions that learners ascribe to schools.

Informal learning institutions, specifically natural history museums, are uniquely positioned to engage youth in interest-driven learning that heavily leverages both digital media and science content. Past studies have demonstrated that informal learning institutions have characteristics that make them significant sites for inquiry-based learning (Paris, 2002); socially-mediated learning (Falk and Dierking, 2000); and constructivist learning (Hein, 1998). Given that young people today are already engaging with digital technologies, the challenge for informal learning institutions is how to support youth in the digital learning nodes and ecologies to which they belong and are already engaged (Goodlad, 1984; Brown, 1999). One way to support youth in their use of digital technologies is to expose them to content and future career paths that align with their interests. For the Field Museum of Natural History (FMNH) and the American Museum of Natural History (AMNH), informal learning institutions whose core research areas include anthropology, botany, geology, and zoology, this means leveraging digital technologies to engage interested youth in STEM careers. As discussed in this fireside chat, a games-based approach to learning has been well-received by youth, at-risk, and underserved audiences. These audiences can find the grand halls of a natural history museum off-putting and physically imposing. Gamifying learning within such a space can help to break down barriers between younger or underserved audiences and science. With extensive experience in developing and delivering games-based learning to youth and underserved audiences, FMNH and AMNH are poised to strengthen their presence in the digital sphere so that they may play a critical role in developing STEM-related competencies in young people.

Case Studies

Here we present brief summaries of some digital learning programs that illustrate the spectrum of current museum programming for youth and teens. Museum-based programs explore how young people can interact and learn in different ways within a research-focused science museum, often leveraging original research, data, exhibits, and/or collections. Our museums seek to gain a better understanding of how youth bring their own capacities in digital media to learning, how key concepts in science are conveyed in new game-type narratives, and how museums can extend this work. These examples were used to launch a broad discussion on the role that digital gaming experiences can play in museum-based learning, the obstacles that museums face when incorporating digital tools, and how efforts like this have the potential to transform museum-based learning in the digital age. We highlight 1) a serious game about paleontology that is in development for use remotely and within an exhibit (Game of Bones), 2) a virtual world simulation and suite of games that are based on museum research but have no presence within museum exhibits (WhyReef), 3) a program blending virtual worlds, engineering software, and data gleaned from museum exhibits and research (Virtual World Institutes), and 4) a day-long learning experience that integrated MineCraft with a temporary museum exhibit on food (FoodCraft).

Game of Bones

Games of Bones (GoB) is a video game being developed and piloted by FMNH to explore how we can use games to better engage museum visitors before and during their visit. The game seeks to enliven the "life through time" exhibits that are standard in most natural history museums. GoB is developed in the Unity 3D game engine for maximum flexibility and is intended for use both within museum exhibits and remotely. GoB game design and mechanics are targeted towards youth aged 9–13, but we expect the game will also appeal to family audiences. The game is web-based, thus playable remotely before or after a museum visit or on a kiosk within the museum. To date, the game has been played by focus groups of middle school students within a museum classroom (but not within an exhibit)

GoB aims to educate museum visitors and online learners about basic anatomy and evolution through ten game levels that map to seminal moments in Earth's history that are represented in almost all "life through time" exhibits. Each level will correspond to a different period in geologic time and will focus on an iconic fossils specimen. Gameplay replicates the activities of paleontologists, with players digging up fossils, re-assembling ancient animals and plants, using museum collections to test basic hypotheses about the organisms' ecology, and making virtual museum exhibits. The single-level game prototype focuses on *Edaphosaurus*, a fossil mammal relative from the Early Permian Period of Earth history (approximately 299 to 270 million years ago). GoB may provide a way for players to apply or improve science skills in context, making the scientific process more accessible and familiar. Gameplay may increase content knowledge, heighten interest in science, and engender positive attitudes toward science among players. Paleontology has a strong feeling of adventure and discovery that may help to draw in youthful players who might otherwise be reluctant to engage with science content. By making science accessible and increasing their content knowledge, GoB has the potential to provide youth players with a better understanding of paleontology and museum research.

FMNH has used an iterative development process, cycling design and development with focus groups of middle school students. Preliminary data gathered at focus groups shows areas where GoB can have a positive impact on learning. Gameplay helped players to understand 1) the realities of paleontology; 2) the tools and methods used by paleontologists; 3) the importance of museum collections for science; 4) basic anatomy; and gave players 5) the ability to evaluate anatomical function.

WhyReef

WhyReef is designed around the FMNH mission rather than around a particular physical collection or exhibit, as are most traditional outreach programs. Thus, it leverages the strengths of FMNH's collection and multi-investigator research programs on coral reefs. The charismatic interconnectedness of a reef ecosystem serves as an ideal platform for WhyReef's goals of increasing science literacy through awareness of and participation in conservation biology and ecosystem ecology. WhyReef allows players to be citizen scientists and also introduces the skills, such as critical thinking and problem-solving, necessary to understand the consequences of biodiversity loss.

WhyReef creates experiences and learning opportunities across channels--increasingly a requirement for the younger generation of learners. Digital media provides an unparalleled opportunity to link learning across the formal and informal spaces of home, school, after-school, and work (Ito et. al., 2008). WhyReef engages players in an array of activities, ranging from assessing coral reef biodiversity to affecting change in an unhealthy reef.

Players participate in activities that allow them to identify and monitor 50 unique reef species, observe who-eats-whom in the reef, and experiment to discern how human events can impact reefs. WhyReef contains two reefs, North and South, allowing players to compare reef appearance and condition. Periodically, one reef is degraded by a problem such as overfishing or coral bleaching. These damaging events are unannounced and progress over the course of weeks, worsening with time. Unlike the real world, reef damage in WhyReef is fixable within a matter of weeks through civic action and group intervention. WhyReef went live March 30, 2009 and received more than 40,000 visits in its first ten days. To date, WhyReef has had more than 175,000 unique players participate.

The scientific accuracy of WhyReef fosters an appreciation for coral reef ecosystems, engages youth in scientific methods and techniques (particularly hypothesis testing and collaborative problem-solving), and assists with science content knowledge of coral reefs. WhyReef 1) addresses the manner in which scientific accuracy in a learning-based virtual world simulates real-life scientific observations about and experiences in ecosystems 2) allows players to mimic scientific processes in order to inform solutions to real world questions, and 3) provides real-life "scientific discovery" moments and opportunities for "higher-level" engagement (Aronowsky et. al., 2011).

One key example of players practicing scientific skills can be found during the Save the Reef activities. During four different month-long occasions a perturbation was introduced into the North or South Reef, resulting in the degradation of that reef. In reaction, Whyvillians were asked to rally and find ways to bring the sick reef back to a healthy state and Save the Reef. The activities in Save the Reef gave Whyvillians several entry points for engagement. These options included: taking a survey to decide why the reef is sick and what is causing it; voting on a Reef Management Plan; making, buying and wearing reef-themed face parts (hats, shirts, signs, etc.) to raise awareness of the sick reef; donating clams to support the Reef Management Plan; and writing articles for the Whyville Times to inspire action. The Save the Reef activities were both highly engaging and popular with players with a total of 1,741 surveys and management plans completed, 218,811 faceparts worn, 5,350,825 clams donated and 92 articles written. By participating in "Save the Reef" activities, players practiced the problem-solving and critical thinking skills employed by marine biologists and scientists and gained invaluable practice in using data and structuring arguments to persuade others to take action.

FoodCraft

FoodCraft combined Minecraft with a temporary museum exhibit, Our Global Kitchen. The youth entered a modded version of MinecraftEdu where they learned they have settled a new community and are in the process of developing their food systems. Participants were challenged with figuring out the mechanics of farming and eating, and what crops they could successfully produce, process and trade. After the first gameplay the youth visited the food exhibit, met with one of its designers, and contrasted the food systems in the game with the real food systems depicted in the exhibit. A second visit to Minecraft introduced a global transportation system and industrial farming and challenged the youth to solve new problems using information learned from their visit to the exhibit.

The program was designed to achieve the following educational objectives. By the end of the day long program, youth were able to: (1) articulate the different elements of a food system, (2) identify some of the factors that influence the food system and their consequences, based on experiences within both FoodCraft and AMNH's Our Global Kitchen exhibit, (3) explain how a video game can create a "need to know" about content in a museum exhibit and how a museum exhibit can provide needed content for a video game, and (4) enhance their abilities to problem solve through collaboration in a digital environment.

Virtual Worlds Institutes

AMNH's new programs grow out of our recent work exploring the educational applications of virtual worlds. Virtual Worlds Institutes provides unparalleled access to the Museum's wealth of science resources, curatorial expertise, and collections, and utilizes a combination of digital sculpting software (Sculptris) and virtual worlds (Active Worlds). Learners use these digital platforms to bring to life their hands-on investigations of fossils, artifacts, gene sequences, and museum dioramas and exhibits.

The Institutes introduce students to the Museum's extensive and unique resources—fossil halls, paleontology collections, astronomy exhibits, science departments, and scientists—and tap into the continued evolution of scientists' use of technology to analyze, model, and communicate scientific data. Each institute culminates in students presenting their digital work, including the hypotheses and analyses behind it, to their families and the AMNH community, who acts as unique and essential resources in the development and execution of these scientific programs.

In 2012 students were enrolled in: (a) Cretaceous Oceans: students were placed in the role of paleontologist to "resurrect" an extinct ecosystem based on fossil evidence from the Museum's collections. This Institute was first offered Summer 2010 and highlights can be viewed in the this video: http://www.youtube.com/watch?v=ORO-pzDvYFNI and (b) What Happened to the Neanderthals?: students assumed the role of paleo-anthropologist to reconstruct the events that may have led to the extinction of Neanderthals and the predominance of modern humans as the only hominid left on Earth. Summer 2012 was the first offering of this Institute.

Discussion

We selected seven questions around which to center the discussion. These questions (Table 1) came from a lively pre-conference discussion among staff at both museums about the role of games-based learning in museums and the role of museums in the future of games-based learning. During the fireside chat, we used www.wheeldecide.com to randomly select a series of focal questions. Once a question was selected, each museum staff member answered the question using examples, data, or anecdotes from the case studies described above. Then the discussion was opened to all participants for comments about their own institutions and processes, as well as further questions. The conversation was both stimulating and informative, such that we only had time to address questions 2 and 3 of the seven questions in Table 1. Several participants tweeted from the fireside chat. The tweets are available in Barry Joseph's blog summary of the event: http://www.mooshme.org/2013/06/speaking-on-science-museums-and-games-at-gls/ Some of the compelling topics included collections-based games, games as a way to change youth mindsets about natural history museums, goals of museum-based programs, measuring impact, and the importance of authenticity for engagement.

Like most informal institutions, museums have to consider a diversity of stakeholders, audiences, and technologies when designing and implementing games-based learning experiences. Natural history museums (NHMs) engage learners from pre-Kindergarten through university to families. We engage learners both onsite and off, through channels including websites, virtual worlds, mobile devices, field trips, summer camps, and afterschool programs. The average museum visitor is a family with two children and two adults in their 30s (see Reach Advisors, 2010). An ongoing study conducted by the FMNH Exhibit Department (in collaboration with the evaluation firm Slover-Linett) to inform the museum's Grainger Digital Initiative, showed that the average museum visitor has a smartphone but wants a break from screens while in the museum. However, these same visitors think that an exhibit without technology and interactives is outdated. Given this diversity of audiences and contrary feedback, it can be challenging to design games-based experiences and museums must be thoughtful about when and how to utilize technology.

Number	Question
1	Do games-based learning opportunities need to be centered in a museum's physical space?
2	How can museums use games-based learning to help youth develop a lifelong interest in science?
3	What are best practices for engaging youth and teens through games with museum collections?
4	What role can museums play in advancing games-based learning?
5	Should museums produce games themselves, or should they serve as facilitators or content experts for game designers?
6	How can museums best offer opportunities for youth to remix content?
7	How can primary collections and research-based data be incorporated into gaming experiences?

Table 1: 7 discussion questions for Fireside Chat.

NHMs and science centers both have missions focused on raising awareness about and engaging the public with science, but typically they take different approaches to achieve these goals. Science centers generally base their exhibits and programming on experiences whereas NHMs base theirs on collections or objects. The centrality of collections to NHMs was highlighted by the first discussion question (best practices for games-based learning using museum collections). For museums and scientists, collections are a tool for actively solving problems and, as such, have great potential within games. But what are good practices for using collections within a game? In GoB, players must answer two simple questions about an unfamiliar extinct animal: what did it eat and how did it move? During gameplay, players use images from FMNH's collections to compare the extinct animal with more familiar living animals (e.g., wolves, ducks, turtles) to form and test hypotheses. Foodcraft is an example of games that create a need to know about objects. In Foodcraft, gameplay preceded the exhibit and potentially changed the way that learners saw and experienced the objects on display. Vanished was a nation-wide game launched in 2011 by MIT's Education Arcade and the Smithsonian Institution. Vanished was played in schools and informally for seven weeks. Gameplay took some players into their local NHMs to find clues in the objects on display. That information was shared broadly within the game to help solve the central mystery. The broader group discussion highlighted how augmented reality games (e.g., ARIS or TaleBlazer) on mobile devices can change the way that players interpret and interact with objects on display. Using AR, objects on display can become clues in a mystery or components of a game; trigger audio, text or video information about an object; or allow visitors to interact with objects in ways that would otherwise be impossible in a static display. An added benefit is that AR has the potential to provide tailored informational or gaming experiences for different audiences (e.g., children, adults) within in a single exhibit.

Most museum-designed games are educational and have explicit learning goals, but in some cases the most important thing a game can do is to change a players perception about the museum itself. When museums attempt to engage underserved, youth, and at-risk audiences, raising awareness of the museum and breaking down barriers (both real and perceived) between a learner and the museum is paramount. This came to the fore with the second focal question (helping youth to develop a lifelong interest in science). Both AMNH and FMNH have found that the games-based approach is a hook to engage younger and underserved audiences with a museum and with science. AMNH and FMNH are in historic, grand, and imposing buildings, but these structures can hinder approachability for young people. Gamifying learning within such a space can make a museum and its content more relatable. For youth who already have an interest in science, games can make them feel confident and capable, and encourage them to explore content more deeply. For youth who like games but are not interested in science, games can reveal the commonality in approach between games and science (solving problems, going on a quest), making science seem more interesting and relevant.

Increasingly, museums are using games to engage and educate younger audiences, but how are museums measuring the impact of games-based learning? Given the limited resources available to museums, most games-based learning experiences are evaluated internally, but not externally. Museums typically have to be selective about which experiences merit external evaluation and rarely have funding for longitudinal tracking. Smaller, intensive in-person experiences like FMNH's Conservation Connection (Aronowsky et al., 2012a) and the I Dig Science collaboration with Global Kids (Aronowsky et al., 2012b) have yielded very promising results on a small scale. External evaluation of I Dig Science (Childs and Peachey, in preparation; Steinkuehler et al., 2012) showed that the program encouraged participants to explore career landscapes and workplace literacies that they may not have previously considered, and created an enjoyable and highly engaging environment in which to acquire and practice science skills and learn science content.

Given that the vast majority of science engagement in the U.S. is informal (Bell et al., 2009; Falk and Dierking, 2010), participants raised the question of whether museums should be solely responsible for evaluating the impact of their games-based learning experiences. Most participants felt that the onus for evaluation lay equally with museums and with learning scientists. A commenter suggested that we need a new infrastructure and new, more stable partnerships between museums and academia to support formative, summative, and transformative evaluation. When museums have to select individual programs for evaluation and dissemination, valuable data on learning experiences are lost. As museum practitioners who believe in the importance of informal institutions for changing attitudes about and increasing competencies in science, we fully support such collaborations and encourage dialogs that would foster such partnerships.

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What's Next in Studying Online Social Networking? Future Research Directions for Creative, DIY-Based Sites

Deborah A. Fields, Utah State University, deborah.fields@usu.edu
Sara M. Grimes, University of Toronto, grimes@utoronto.edu
Alecia Magnifico, University of New Hampshire, amagnif@illinois.edu
Jayne C. Lammers, University of Rochester, jlammers@warner.rochester.edu
Kimberley Gomez, University of California, Los Angeles, kimgomez@ucla.edu
Jen Scott Curwood, University of Sydney in Australia, jenscottcurwood@gmail.com

Abstract: Social networking sites (SNS) have garnered a great deal of media attention (and some research interest) in recent years. Among these, sites which focus on the making and sharing of media, or Do-It-Yourself (DIY) social networking forums, are surfacing as spaces with great potential for learning and as supportive, engaging communities. In this Workshop, we seek to map out a new agenda for research on these types of sites over the next decade. We bring together several scholars who have studied DIY-based social networking forums to engage with graduate students and interested researchers in identifying the key questions, themes, and distinguishable attributes that will propel study on this genre of sites into the next generation.

Introduction

The growing number of children and youth now using online 'social network sites' (SNS) has led to a veritable surge of news stories, media attention, and economic investment. In tandem with these developments, there is a need to develop a better understanding of the ways that these digital technologies mediate children's socializing as well as the relative opportunities and limitations for their participation in them. In reviewing the existing research in this area, however, it quickly becomes apparent that there remain a number of important gaps in the literature (see Grimes & Fields, 2012). One of these gaps is a myopic focus on traditional social network sites (e.g. Facebook, MySpace) that are often the focus of popular media, to the exclusion of other social networking forums, such as games, virtual worlds, and online communities. Yet these forums have an underlying social-ness to them that begs consideration and comparison. In this Workshop we will consider one particular type of online social networking forum that is often overlooked in popular discussions of social networking: DIY-based social networking forums that focus networking around kids' own creations shared online.

We situate our discussion under the broader topic of online social networking to highlight the ways that social networking and creative design can be mutually supportive. This Workshop is intended to draw together graduate students and interested scholars and to coalesce this field and identify questions that will propel us into the next phase of study of this specific genre of social networking forums. Bringing together several researchers who have studied kids' engagement in DIY-based social networking forums in addition to conference participants, we will discuss questions such as:

- What defines DIY-based social networking forums as opposed to other genres of online social networking?
- What productive practices are emerging in these sites that support kids' learning-by-making and their engagement with creation, sharing, and critique?
- What influences do site-design, community roles, and genres of DIY media have on the social fabric of the sites?
- What policy issues are emerging from kids' sharing self-created content online, including but not limited to copyright, privacy, ownership, and age-based regulations (e.g. COPPA)?

Below we provide a brief background on current issues in the field and why DIY-based social networking forums should form a key new field of research. Then we suggest some directions for conversation in the Workshop, outline the format of the Workshop, and describe the participants. In this Workshop we bring together several scholars to compare research and findings from different sites and perspectives, to consider overarching issues beyond just specific websites/affinity spaces, and to seed conversation on next directions. We strongly encourage graduate students and scholars of online social networking to participate!

From Social Networking Sites to DIY-Based Social Networking Forums

Taken as a whole, existing large-scale reports on SNS usage paint a rough, but multi-faceted, picture of the rise of social networking among increasingly younger users and its ongoing spread across a diverse array of platforms and contexts (Grimes & Fields, 2012). While participation in social networking forums has increased steadily over the past several years (e.g. Lenhart, Purcell, Smith, & Zickuhr, 2010; Livingstone, Haddon, Gorzig, & Olafsson, 2011), we still know very little regarding who the participants in these spaces are, what makes up these spaces, what kinds of activities kids engage in, and what those activities mean for their learning and development. In particular, when studying kids' online social networking, we should consider not just traditional social network sites like Facebook and MySpace but also virtual worlds, networked games, and project-sharing sites. To this end, Grimes and Fields (2012) suggest moving beyond the more specific "social network sites" (SNS) as defined by Ellison and boyd (2007) to consider a more inclusive range of online social activities, practices and platforms, defined more expansively as "social networking forums" (SNF) and including virtual worlds, networked games, and project-sharing sites that have an underlying social-ness to them. In this Workshop, we particularly highlight social networking forums focused on sharing and socializing around kids' own self-created media.

One key online social networking practice that has emerged in recent years involves creating, sharing, and socializing around user-created content. Pew reports that "Online sharing of content that teens have created themselves has remained steady since 2006; 38% of Internet-using teens say they shared content online in 2009, similar to the 39% who said the same in November 2006" (Lenhart, 2009, p.23). Despite these statistics, there is reason to believe that trends of online sharing are nevertheless trending upward. In 2002, research by the National School Boards Association revealed that only 13 percent of students aged 9 to 17 years were involved in sharing or looking at art and stories created by others online. Equally intriguing is a trend towards kids' gaming activities overlapping with the production of digital content—a key, yet often overlooked, way in which young users act online. Console games targeted at children and teens, such as Media Molecule's *LittleBigPlanet* for the Sony Playstation 3, Microsoft's *Kodu Game Lab* for the Xbox360, and Nintendo's *D.I.Y. WarioWare* for the NDS, feature tools for creating game items, characters, levels and mini games that enable non-expert players to contribute much more directly to the game than was previously possible. Because these games are Internet-enabled, players can share their finished products with others, contributing to vibrant networks or 'communities' of user-creators. Each of the major console manufacturers (Microsoft, Sony, and Nintendo) now provide online services through which players can download (free or purchased) content submitted by other players, and upload their own creations. A wide variety of social affinity spaces—ranging from off-site forums to in-game publications that encourage player-created content—also allow players of games like *The Sims* and *Neopets* to contribute fanfictions, game guides, graphics, and movies to share with fellow players (e.g. Lammers, 2012; Magnifico, 2012).

Since children and youth are generally excluded from participating directly in public life, it is worth highlighting the significant opportunities for creative collaboration that kids are given in DIY-based social networking forums. Sharing digital artifacts with others online, especially in an online SNF where others are creating similar types of artifacts, affords many educational opportunities, including designing or writing for a specific audience (Magnifico, 2010), giving and receiving constructive criticism (Black, 2008), creating projects collaboratively (Brennan et al, 2011), studying the design of others' projects, remixing or redesigning the designs of others (Monroy-Hernandez et al, 2011), and making mods of games (Hayes & Gee, 2011; Grimes, forthcoming). At the same time, kids' newfound roles as cultural producers raise important questions about copyright and fair use within SNF that feature "remix" and fan activities, as well as young people's knowledge of these processes and the challenges that creative work may present for the various stakeholders involved. For instance, kids' newfound roles as producers introduce a number of important challenges to existing legislation on authorship, intellectual property ownership and copyright (Grimes, forthcoming; Shade, Porter, & Sanchez; Steeves, 2006; Turow, 2001). These roles also raise complex new questions about kids' cultural rights including freedom of expression and access to fair use exemptions.

Further exploration of these issues is especially important given that the existing literature appears to contain fragmented and occasionally conflicting data about how participation in DIY-based SNF extends beyond basic questions of access and usage rates. For instance, in a study of online content creation and sharing among US teens, Lenhart et al. (2010) found "no differences in sharing content by race, ethnicity, family income or parent's education level" (p.23), either in 2006 or in 2009. In contrast, Hargittai and Walejko (2008) found that young adults whose parents had higher levels of education were more likely to create and share content online, while young adult men were significantly more likely to share creative content online than young women. These conflicting findings highlight the need for a more comprehensive understanding of such content-sharing practices and a much more consistent incorporation of social equity questions within future research in this area.

Mapping the Research in DIY-Based Social Networking Forums

Despite the breadth and diversity of practices and technologies involved, we suggest that DIY-based SNF share a set of recognizable attributes that distinguish them from other websites and other SNF in general. Grimes and Fields (2012) argue that SNF can be identified and compared by several key features, including *forms of communication*, *personal profiles*, *networking residues*, and *hierarchies of access*. As a composite, one could say that this set of features defines the 'genre' of a social networking forum. In using the notion of genre as a framework for mapping the social networking terrain, they draw inspiration from Ito et al. (2010) who applied a similar approach in identifying a key distinction between 'friendship-driven' and 'interest-driven' types of online youth participation. Ito and colleagues articulate that the distinction corresponds to "different genres of youth culture, social network structure, and modes of learning" (p.15). Generic categories of use (or participation) are particularly relevant to our discussion as they allow for analysis across platforms, which is an important methodology for challenging the binaries (e.g., offline vs. online, SNS vs. virtual world) that dominate discussions of kids and social networking. Building on the categories suggested by Grimes and Fields (2012) as a starting point, in this Workshop, we will anticipate further directions by adding to, expanding, tweaking, and developing their model of SNF to the specific genre of DIY-based SNF, just as they built on the model of social network sites suggested by boyd and Ellison (2007).

With this Workshop we are concerned with mapping out key features of DIY-based SNF that can propel this social networking genre forward as an emerging field of research. Although we cannot fully anticipate what directions this discussion will take, below we suggest some key areas of DIY-based SNF to consider, including the categories suggested by Grimes and Fields (2012) but also building beyond them.

Forms of Communication

A defining characteristic of online social networking forums is their support for participants to communicate with one another. This function is provided via options such as live chat, voice chat or even video chat (e.g. via Skype or Google Circles) in addition to threaded posts, comments, and traditional messages akin to within-site emails.

- What different forms of communication are available (designed-for) and how are they utilized?
- What user-driven types of communication are evolving and how are sites changing based on user-input?
- How does the type of content created and shared influence the forms of communication used, such as gendered-expectations (i.e. assumptions about gender of participants who make certain types of media like fanfiction or video games) or forms of communication embedded in the very media users create (i.e., messages for other users in stories, video games, or art projects)?
- What different genres (vs. forms) of communication are present in a site, for instance constructive criticism, praise, demonstration of affinity, and not-designed-for communication like role-playing and general socializing?

Personal Profiles

Another key element of the SNF genre is the user profile. As a personal representation on an SNF, the profile is the means by which people learn about each other. At minimum, a profile usually consists of a username and one or more images or text descriptions.

- What kinds of personal profiles are there and how are they defined by user-created content? For instance, portfolios, or a display of user-created works, are often a common type of profile on DIY-based SNF in places like *Scratch* and *Storybird*. Alternatives include pages, avatars, and homes.
- How are design elements such as badges and site achievements included in profiles?
- How do users incorporate their content around and alongside this site-generated content?
- How do personal profiles serve as identity displays for users?

Networking Residues

Networking residues, or the traces of one's social connections to other users on a site, are another generic aspect of online social networking in which users can demonstrate their affinity with one another. These residues establish and reify connections in several visible ways on SNF and are highly popular forms of participation. Networking residues include posting *comments* on walls or projects; *liking or <3 (hearting)* posts, comments, or projects; creating lists of *favorite* projects; associating in interest- or person-based *guilds, groups, and galleries*; exchanging *gifts* of objects or virtual wealth; and creating friend lists. They overlap with some forms of communication like visible comments on projects or posts, but make social networks visible in ways that live chat or private asynchronous in-system emails and other messages do not.

- What forms of networking residues are common in DIY-based SNF and how are they utilized?
- What value do networking residues have related to user-generated content?

Hierarchies of Access

Social networking forums also have different hierarchies of access, allowing some users more kinds of participation and privileges than others. Documenting these can help illuminate different avenues to participation on a site, showing who has access to what. Some hierarchies might be controlled by designers (e.g. chat filters, special types of membership defined by fees or high levels of participation) and some by individual users (e.g. friend lists).

- What hierarchies of access are common in DIY-based SNF and how are they used?
- What user-generated hierarchies of access are present and how are they used?
- How do user-developed groups such as design collaborations or communities within a site define new hierarchies and to what end?

User-Generated Content

DIY-based SNF are defined by users creating content, often of a specific genre (story, fanfiction, programming projects, art, music, etc.).

- How does the type of user-generated content shape the design of a site, the participation in a site, and the forms of communication, personal profiles, networking residues, etc. on a site?
- What values emerge regarding the quality, quantity, and range of content users produce in a forum? For instance, are certain types of content valued as more difficult, more rigorous, or more creative types of content?
- What different types of content are present in a site, including personal content, curated content, favorited content?
- What are the attitudes and usage of new media practices such as remixing, and what issues of ownership emerge within a site?
- What are specific sites' rules and attitudes toward user-ownership, copyright, and privacy? How visible are these rules to users?

Roles and Trajectories of Participation

Participants in DIY-based SNF have the opportunity to take on different roles, including more obvious content-producing roles but also including many other roles, perhaps as yet undocumented or hidden.

- What range of roles do users take up, including content-producing, socializing, lurking, advising, etc.?
- How do users shift roles over time or take up multiple roles? How do these different trajectories shape the site?
- How do these roles relate to personal interests, relationships, and backgrounds?

Methods of Research

There are many different ways to research DIY-based SNF and we wish to consider a range of methods, their different affordances for research, and related issues such as ethics in this discussion. Here we include different methods such as data mining of backend collected data, ethnography, discourse analysis, collective or multi-site ethnography, artifact documention and analysis, and others.

- How do different methods of research lend themselves to specific kinds of findings?
- How can multiple methods of research inform each other? How have current teams of researchers combined multiple methods, and to what ends?
- What ethical issues arise from different forms (e.g., privacy, waivers of consent, lurking, etc.) and how are researchers dealing with these?

Leading Participants

Several different researchers will participate in this Workshop, bringing experiences in researching a range of sites with different methods. Below we briefly describe the background and relevant research of each participant.

Deborah A. Fields: Chair

Deborah Fields is an assistant professor at Utah State University who focuses on how interests, identity, and learning can come together in kids' lives: in ways that connect across different social settings. These interests have guided her studies in virtual worlds and STEM (science, technology, engineering & math) education in and across classrooms, clubs, and digital social environments. She spent several years using ethnographic and big data methods to study the virtual world of Whyville.net, which led to writing about identity, avatar design, ethnicity, gender, and cheating in that world. Related, she recently co-authored a critical review of children's participation in social networking forums for the Joan Ganz Cooney Center. Currently she is applying this background on studying kids' social activities online to Scratch.mit.edu, a DIY-based social networking forum focused on kids' sharing, commenting on, and remixing computer programs in the form of stories, music videos, animations, and video games. Thus she is especially interested in digital media platforms that draw together creative production, personal expression, and social sharing of kid-created media.

Sara Grimes

Sara Grimes is an assistant professor in the Faculty of Information at the University of Toronto, and Visiting Professor in Book and Media Studies at the University of St. Michael's College. She researches primarily in the areas of children's digital media culture(s), play studies and critical theories of technology, with a special focus on videogames. Sara has published work exploring the commercialization of children's virtual worlds and online communities, the articulation of a critical theory of digital game play, discussions of intellectual property and fair dealing in digital game environments, as well as the legal and ethical dimensions of marketing to children online. Sara's current research tracks the growing phenomenon of "child-generated content" (user-generated digital content created by children aged 12 years and under) in digital games and online environments, focusing on what this development means for children's cultural rights, as well as for existing regulatory frameworks and standards of practice. She has applied this focus to sites such as LittleBigPlanet and Storybird where children share videogame mods and stories respectively.

Alecia Magnifico

Alecia Magnifico is a learning scientist who is particularly interested in adolescents' literacy learning, participation in digital media, and critique practices. She has conducted ethnographic research in *Neopets*, working to capture players' multimodal composition across various areas of the site, how they carry DIY creative practices across multiple sites and contexts, and how literacy practices like critique and audience analysis become elements of play (Magnifico, 2012). Additionally, Alecia is interested in how teachers incorporate online collaborative writing and critique in their classrooms using peer review software tools like *Scholar* (e.g. Magnifico, Kline, Woodard, Letofsky, Carlin-Menter, & McCarthey, under review). By studying both classrooms and DIY social networking forums, she hopes to gain a better understanding of adolescents' formal and informal literacy practices, how these practices translate (or do not translate) from home to school learning activities, and how composing for real audiences and with real purposes affects adolescents' impulses to write and create.

Jayne C. Lammers

As a literacy scholar interested in digital media and learning, Lammers conducts ethnographic research of young people's literacy learning in fan-based DIY social networking forums. Her work studying *The Sims* affinity space examined young women's production and sharing of *Sims* fan fiction – multimodal, hybrid texts that pair images and words together to tell stories using the videogame to visually represent the characters and settings. This research offered insights about tensions that arise within these DIY spaces (Lammers, 2012) and the pedagogic discourse used to create official knowledge within fan spaces (Lammers, 2013). Her current project is a longitudinal investigation of a developing adolescent writer's practices in three contexts: school, Fanfiction.net, and home. Through this and other projects, Lammers is interested in further exploring the potential of DIY social networking forums as sites of informal literacy learning and identity development for adolescents with the aim to inform in-school literacy instruction and practice.

Kimberley Gomez

Kimberly Gomez is a professor of learning sciences who researches digital technologies and new media literacies centered in two areas. First, she explores the affordances of social learning network sites investigating how youth, and the adults who mentor them, build knowledge, share knowledge, and engage in meaning-making opportunities in out of school contexts. To explore the affordances of such sites, she engages in-depth analysis of new media artifacts, including video, blogs, discussion threads, photos, and personal profile pages. The second line of research explores the affordances of learning technologies in high school science classrooms, and examines the adoption of these technologies by students and teachers. For example, she considers the impact of classroom use of Latent Semantic Technologies on changes in students' ability to summarize biology content. Similarly, she is documenting the impact of the use of such technologies on teacher science pedagogy. Recently, she has begun to explore the impact of medical wireless technologies on how patients' learn to monitor and support their health. Her work is guided by cognitive, constructivist and situated perspectives on learning.

Jen Scott Curwood

Jen Scott Curwood is a lecturer in secondary English and media studies at the University of Sydney in Australia, where she is a lead researcher in the Sciences and Technologies of Learning Network and affiliated with the Centre for Research on Computer-Supported Learning and Cognition. Her research focuses on adolescent literacy, technology, and teacher professional development. Jen is a former middle school language arts teacher and high school English teacher who completed her Ph.D. at the University of Wisconsin-Madison. In addition to her research on secondary teachers' participation in learning communities, she is engaged in an ongoing ethnographic study of young adult literature and online affinity spaces, which include social networking forums such as FanFiction.net, Mockingjay.net, TheHob.org and social media tools like Tumblr, Twitter, and Facebook. Jen's recent work has appeared in the *International Journal of Learning and Media*, *Journal of Adolescent & Adult Literacy*, *E-Learning and Digital Media, The Reading Teacher,* and *Literacy*.

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Dancing (and Wrestling) with Learning Objectives and Game Mechanics

Bert Snow, Muzzy Lane Software, bert@muzzylane.com
Caitlin Feeley, The MIT Education Arcade,
Jason Mathew Haas, The MIT Education Arcade, jhaas@mit.edu
Peter Stidwill, The Learning Game Network,
Dave McCool, Muzzy Lane Software, dave@muzzylane.com
Scot Osterweil, The MIT Education Arcade, The Learning Game Network, scot_o@mit.edu
AND OTHER CONTRIBUTORS IN THE SESSION.

Abstract: Designs for intrinsic learning-game are often created through processes where game mechanics are inspired and built from the learning objectives the game designers want to embody in the play experience. It sounds straightforward, but in our experience it's not: Mechanics are built and played, and the play teach the designers new things that lead to looking at the objectives differently, and therefore the mechanics, in a challenging creative cycle. In this Fireside Chat, we'll host a lively discussion of practitioners who have been living this process.

A Spirited Discussion among Practitioners

The aim of this Fireside Chat is to spark a lively discussion among the many wizened (and scarred) designers of learning-games who will be at the conference. The intent is to focus the discussion on one aspect of design process: the choice and development of game mechanics building from the learning and practice objectives the designers are working with. We will talk about the experience and the lessons of the work itself - the goal and concepts we begin with, and the ways in which the work itself changes our understanding of the starting-point learning objectives, and how game elements can be combined to embody them.

The Authors (Wrestlers)

The authors are designers who between them have many games on their resumes, and in particular a lot of work and thinking about learning games. While we generally share an interest in working forward from core learning or practice objectives, our approaches have tended to vary quite widely.

The authors' work has ranged from ingenious puzzles to complex strategy games to open games-as game-building-systems to radical MMOs and mobile collaborations, language-learning-through games, and much more. In addition to learning-game design and development, we variously have written extensively on game design and learning, have helped invent game genres, and have worked with educators in many different disciplines. We don't expect to always agree – and hope for several good arguments and also to draw out experiences and ideas from everybody who joins us.

The Focus

Playing a game involves attention to the goal a player is trying to reach, the role being played, and to the tools, actions, and strategies the player can use to reach the goal. To succeed, the player must learn about all of these elements – what tools make sense when, what strategies worked – and didn't, what the responsibilities of a role really mean. To design a game to inspire learning in a particular area, it can make sense to look for goals, tools, actions, and strategies that relate to that area – that are intrinsic to it. Hopefully then, play will naturally lead the player to engage with and learn about those elements – and the topic area itself.

To accomplish this, the authors have different processes and favored approaches that we start with….but in game design things don't usually go as planned – and that's what we want to focus on – how the curves and lessons of design and development inform and change the starting point – and how to take advantage of the creative opportunities in the process while not losing our way.

Including the Audience

The questions were shared with attendees, with an aim of bringing to light interesting experiences and lessons from the rich group of designers who will be at GLS. Within the session we will ask questions, and seek answers and examples from the audience as well as from each other.

The Stories

The following are the stories told by our five initial storytellers, plus by many others who we invited to contribute after our first round of stories was complete.

BERT SNOW: Vice President of Design, Muzzy Lane Software

I'm Bert Snow; I lead the design work at Muzzy Lane; we are a studio that has been working on designing and developing games for learning for almost 10 years. I'm going to start with a story about objectives and the choice of game genre.

I'll talk about a project to develop a game where students work with the concepts of marketing (concepts like positioning, pricing, promotion, and distribution). The game's audience would include students in Introduction to Marketing courses. We had two eminent marketing instructors working with us at the start of the project who were very enthusiastic. One was data oriented– ready to think about the underlying game systems, and the other was very enthusiastic and had a lot of ideas about how the games might work. Specifically, he was very bullish on doing a real-time game. (You may know that Muzzy Lane has a strong background in turn-based as well as real-time games, and we've learned – partly from this project – that this is an important distinction.) There were some good arguments for taking a real-time approach: the students are an active group, and it was felt that speed was important, and real-time tycoon-style games have had commercial success.

The important point for this story is that we made a quick decision to choose that genre – real-time strategy – without a thorough process. We went forward through a design phase and built a prototype. We were able to build actions and roles to pull in many of our specific learning objectives: players formulated a product (a juice drink with an acai-berry like 'super-fruit' ingredient), targeted a market, chose advertising messages and media, and so forth. It looked great. But when we started playtesting the prototype, we found there were issues with players being able to take in the feedback and use that information to understand the consequences of their actions in a way that would help them develop better strategies in the future – a key goal.

We tried a variety of changes and interface solutions, which helped somewhat, but in the end it was a mismatch of genre. When we had an opportunity to re-tackle this topic, we chose a multiplayer turn-based strategy mechanic, and the resulting game was much stronger – as a game and in meeting our learning objectives. The turn-based mechanics provided time for players to look at what competitors were doing as well as analyzing their own performance, and let us deepen the interaction and feedback in each area of marketing.

I guess the one sentence lesson is, "Don't assume that the genre you think you're going to build your game is it the genre that you should build your game in." We've found it's important to look carefully at the strengths and weaknesses of different genres (and combinations of genres) in relation to your play and learning objectives.

CAITLIN FEELEY: Game Designer and Project Manager; The Education Arcade, MIT

I'm going to tell you about a casual game we did called *Farm Blitz*. I wanted it to be called Money Bunny, but I didn't get to make that decision. We were approached by a financial education group that said, "We need a casual game to teach low to moderate income women who are heads of household how to avoid and manage high risk debt. It needs to be a short casual game, maximum 20 minutes seat time. That's not optional. So I had to figure out how to make a game that was casual and appealing to non-gamers that dealt with math and debt. And all I needed was to somehow convince them to get a root canal in the middle of it to make it the most appealing game ever."

So we got to talking about this demographic -they're at higher risk for payday loans, predatory credit cards, things like that...what the big kind of educational and psychological barriers there are to making good decisions about debt. And part of it is, a lot of people were raised thinking, "You've got to save money, you've always got to have an emergency fund." if you have a savings account with a quarter of a percent interest, but a credit card with 18.5% interest, there's no sense in saving your emergency fund when you could be paying down the credit card. But people may still have a thousand bucks, maybe even two thousand in their emergency fund while their credit card is spiraling out of control.

These people know what their interest rates were. As Scot likes to say, we could write down everything they needed to know on a 3x5 card but they wouldn't actually internalize those lessons. I tried to think of a way that would make this very easy to grasp and appealing. I thought of a story I was read when I was a very little girl, about some parable about a man in China requested a single grain of rice to be doubled every day from the Emperor. By the end of the month he had all the rice in China, because once you start compounding things it gets completely out of control.

So what we ended up with was a Bejeweled-like mechanic where you had a farm. You had to line up little vegetables in rows of three or more, and you had to harvest them. You earned money from that. Meanwhile, you could buy more seeds, garden tools, other things to make your farm awesomer. But every time you did that it cost you a bunny. There was a bunny that got put in a pen. “Here’s your seeds, and here’s your requisite bunny. You must take a bunny if you take seeds. It’s free bunny day!” There’s a pen, and as long as you have fewer bunnies then there are slots in the pen, you’re okay. If you have more bunnies than there are slots in the pen, they get out and they eat your vegetables and ruin your life. And of course, eventually, bunnies make more bunnies. So if you have more than one or two bunnies, it’s not long before your farm is a desolate wasteland, and it’s game over.

So then we had this idea to teach the relative value of savings to debt. We had this idea that you had a tortoise, because tortoises grow really slow, and you had to feed the tortoise periodically. That eventually evolved into you had an orchard. You could put money into the orchard, and money was safe. The bunnies couldn’t eat it. Periodically something like a tornado comes and destroys your entire farm, but the money would be safe in the orchard. The trees would grow very, very slowly over many, turns. Eventually the trees would be huge and dripping with diamonds. It took a really long time to get a diamond tree. But if you needed the money you could chop down a tree and use it to pay off your bunnies. Very quickly people figured out the balance between paying down the bunnies as fast as possible, and then socking away everything they could possibly spare into the orchard until they needed it. And people would be very careful about which trees they harvested...”oh, this one’s been growing for a long while, I’m going to let that investment grow.” It really worked well, we tested it with a group of low income women. So the fact that this made this very approachable in a very easy to grasp way worked out really well. We were actually nominated for a G4C award (and lost to Bert!).

If you had to take one lesson from that?

Ask yourself why people aren’t grappling with whatever it is you want them to learn or understand. It’s not enough to say, “Oh we just need to find a fun way to teach it.” There’s a lot of ways to make something fun, and there’s a lot of things that people need to learn. You need to ask yourself, what is standing in the way? Nobody thinks debt is good for them, so why aren’t they stepping over that line and making the decisions they need to make? And then think about to break down that psychological barrier and make it approachable.

JASON HAAS: MIT Media Lab

I’m going to tell you a story about *Vanished*, our science ARG from two years ago. The lesson up front: The right subject matter expert is magical. For us, we were pursuing a collaboration with the Smithsonian. We have this great data about silverback gorillas, and we want to make a flash game about extinction and what that might mean for silverback gorillas. Seems like a good idea, we could get some traction there. They wanted to get their scientists involved, putting the museum out there.

We got to talk to Matt Curano, who is a paleontologist at the Smithsonian. We were talking with Matt...he was a bit cranky that day, he was all “I hate the way science is taught. You know what the worst thing is? The scientific method. The thing is you do all those steps but you never do them all.” nosing through data and stumbling across something. Conversations in the hall that would spark something, rarely do you go through all the steps in order. Do you inspire people to learn with ordered steps? Not necessarily. What’s the most important? It is colleagues. Working with other people is what science is about. I’d been reading about ARG’s a lot at the same time.

People communicate to solve puzzles, they wouldn’t always start in one place and move in a straight line. As a result you can start to see that this might be what middle school students for instance can use to get inspired about science. It’s more like something they would do on their own. Organizing themselves to solve a puzzle is really important.

Having it be something that had an end point kept it sustainable. It allows you to put in benchmarks and say, “If by this point you haven’t done X we need this type of scaffolding.” for the most part that really worked out. The other great thing about ARGs is you can bring in People like Matt. We have Carrie Brulhide, talking to kids about what it means to do forensic anthropology, doing archaeology on people’s bones and with civilization may have been like based on those sort of things. Having the right content matter experts who are willing to interact with kids and interact with them like they are adults is amazing. So finding that right subject matter expert in the first place, someone who has good opinions, who knows their field, isn’t just participating in traditional education, has ideas about how their field should be taught and what their field really is cannot be replaced.

PETER STIDWILL: Executive Producer, Learning Games Network

I'm going to talk about a game, *MP For A Week*, that I made for the UK Parliament while I was working for the House of Commons and House of Lords in London. The overall aim of the game was to explain what Parliament does, and demonstrate what role it has in the context of kids' lives.

So the first big challenge appeared to be that kids aren't generally interested in politics. However, when we sat in on the sessions where kids visit Parliament, and we talked to them and held focus groups, it turns out they are actually very interested in political issues. But they are turned off by political parties and a lot of the coverage they see on TV. For example, Prime Minister's Question Time, the sparring match between the prime minister and the leader of the opposition. Although entertaining, the arguments can be petty, and it actually disengages many people as it reinforces the 'old boys club' stereotype. It's very good drama and the media loves it, but unfortunately it puts a lot of people off.

Coupled with that, when we bring kids into Parliament, they are often awed by the building itself, which is very old and ornate. It's a potential hook to get kids interested, but on the other hand they're in a palace - the Palace of Westminster - and how distant is that from their lives? How can politicians there be representing and legislating on my behalf? So we tried to take advantage of the building but show that real work goes on here. We had to summarize what Members of Parliament (MPs) did, and put kids into their shoes. But it turns out that it's not that simple to figure out what MPs do. The MPs themselves don't agree on exactly what it is they should be doing - there's no job description. Plus, in the middle of game production, there was the expenses scandal, where many MPs were using public money in ways that the public did not like. That was an interesting backdrop to launch this game.

We wanted to ensure that we got the perspectives of everyone involved in the political process. We interviewed a lot of people about what they do. And through that, we realized that what we needed to do was simulate a complex system of people, lobbyists, journalists, MPs, constituents, etc. We wanted to try to get across the nuances of the political system. One of the big challenges was that everyone we talked to had ideas about what should be in the game, although many did not necessarily have much experience with gaming or games. So it was a case of pulling in all these ideas and working out our learning objectives. We had to ask ourselves: how many learning objectives is too many, and what's the ideal amount? It depends on the game, of course, but if you try to do too much, the game will fall apart. We created a shortlist of core learning objectives to inspire our game mechanics, and then used a lot of the other rich material and suggestions as authentic content to fill the game.

My take home message

Do your research, get all your subject matter experts involved, and really get into the heart of the content to get all the insights. But also be clear about what it is you're trying to achieve with the game and don't try to do too much.

DAVE MCCOOL: President, Muzzy Lane Software

So my story is about a game related to government as well – a common theme! This is a project for the Intro to American Government course, which is widely taught on college campuses, and required in states like Texas and Georgia. We talked to lots of instructors, and found that the course is almost universally disliked students (especially where required). The kids do not want to be there. So one challenge was to build engagement and interest. We also had a book full of learning objectives – lots of them; Civil rights, civil liberties, how the branches of government work, elections, and so on. We met with teachers, and looked for a player role and set of goals that might address all of this. What we came up with was running for the House of Representatives, legislating once you're elected, and trying to stay in office. The game is called *Government in Action*, You raise money, sponsor bills, talk to the media, work with your party, try to stay in office. We thought a game could do a great job of getting students inside the system – to see what's interesting about it.

Another influence was role-playing games. Teachers have often done live-action role playing with classes but it's a lot of work, and they were interested in something more approachable So the genre we chose is a multiplayer turn-based strategy game, with about 18 players playing different representatives, competing as Democrats and Republicans. Fundamentally, it's a resource management game where you're balancing spending time in your home district getting elected and working with your constituents, versus how much time do you spend in DC co-sponsoring bills, getting bills passed. You work with a cast of characters, including the president, lobbyists, and the media, constituents.

After getting this core game working, we found we were able to add back in some of the learning objectives we'd set aside earlier: For instance, in your home district, if you're doing a "Town Hall Meeting" to raise awareness on an issue you care about, a constituent might say "I hate the way everyone's criticizing the president, we should just throw them in jail", and you need to respond in a way that shows understanding of the Constitution and the First Amendment.

My takeaway lesson?

If you start with a wide group of objectives, it's valuable to focus on a few, build a game what works there, and look for opportunities to add others to that core.

SCOT OSTERWEIL: Creative Director, The Education Arcade, Learning Games Network

I'm going to start with a light bulb joke from the advertising industry: How many creative directors does is take to change a light bulb? Why does it have to be a light bulb? I think that should apply to all game designers. We should always be interrogating our objectives by saying: Are these the right objectives. Learning objectives are always: I want the player to learn this. Not only is it impossible, it's anti humanistic.

Let me tell a story to turn that around. We got approached by the Gates Foundation to create a game about language learning. Learning language, research tell us: It sucks, no-one likes it, there are people that do well on those kinds of tests but they can't actually speak it. So I tried to interrogate my experience, and this is the question I tried to ask: What's the game? I went back to my experience with 3 years of French and then working in Paris after a 20 year gap. I built up a game idea around how long could I talk before someone realized I was an American. What was going on there was, it was an identity issue. It mattered to me to be someone who was not bound by my language, and so when we started doing the language game I brought that back. Could we give people the opportunity to take on a new identity, and see the empowerment of beginning, whatever stage you're at, to master new things? That's what games are good at after all.

We designed a series of games, in which your goal is not to say or do anything perfectly, but to keep incrementally in contact with other players and become more capable. To interact in the world, and become more capable. Over time we hope to work in a narrative about identity. To go back to this, interrogate the objective. Each of these stories started with an objective. IT wasn't about putting a set of facts together. It was about where was the truly game like experience that matters to us as people as we engage in these areas. That's always the challenge and always the learning curve.

ADDITIONAL STORIES FROM PARTICIPANTS IN THE SESSION

DAVID GAGNON: Director: The ARIS Project

Hi, I'm David Gagnon and I work at the University of Wisconsin directing the development of mobile educational games. I'm going to try to combine two of the ideas that have come out in a single story: First, avoid picking a genre up front. Second, learning objectives need to be challenged, and the subject expert's first take may not be best.

I had the opportunity to work with a really amazing subject matter expert, Teri Balser, a professor of soil science at UW. She is an avid gamer and a really great professor, winning the "Professor of the Year" award a year back. As we began a project, she said, "I really want to get people in the soil, I want people to get in there and look around." this was a great way to start a discussion, and we began experimenting. After a short run of doing some whiteboard storyboards, the design quickly became a real-time, top down game. The players will manage bacteria and explore these underground worlds, find resources, multiply their units and claim new territory. Everything was fine until we realized that the scope of the content that would fit this genre was REALLY small. It would end up being only a few weeks worth of the class. As we tried to expand the design by throwing more content at it, scaling from micro to ecosystem-level contexts. It was becoming obvious that we were doing more work than the players ever would - a bad sign. The design was broken and we realized we needed to try a whole new approach.

So, throwing out both the learning objectives and the genre,, someone on the team asked Teri, "You teach a class in this, what's the hardest thing to teach? What lecture do you dread doing?" She had a near instant response, "The nitrogen cycle!" The topic was taught in a number of courses and is a complex mix of biology and nasty chemistry. Within the hour we had a sketch of the nitrogen cycle, with cows pooping and fertilizers running off up on the white board, a graph of possible states, paths and actors. It looked just like a board game. Within a few more hour long meetings we had a functional board/card game that was fun to play, we'd shifted genre and totally redefined the thing.

It has remained my favorite game to create. It isn't even computer based! Cross player collaboration and banter came for free and everyone from middle-schoolers to graduate students love playing it. The majority of the budget was spent on art and play testing instead of software development. We had to totally throw out our learning objectives, we had to ask the basic questions about what is worth teaching and hard to understand. As soon as you start thinking about games you've already played, they color things you see in game design. It's hard to break out. I don't know how, but I think it's important.

LUCAS BLAIR: Educational Game Designer, Little Bird Games

My name is Lucas Blair; I'm an educational game designer at Little Bird Games. A couple years ago I was a PhD student at a game lab. Clients would come to the lab with pretty random subject matter and they would always want us to make games because that is what our lab was known for. During one meeting we had a new client that wanted to teach continuous process improvement and our source material was a series of excel spreadsheets.

These were things like charts which were like tools used to crunch numbers and optimize processes in factories. I immediately said I don't think I can make games out of this but I think I can make the learners think it's a game. So we split the material into two simulations that taught when and how to use the tools.

As part of the simulation we created a fake factory. I wanted to make it seem bigger and more fun than it really was. So the factory made ammunition that would prevent an impending alien invasion. The player had to optimize the processes in the factory. We used comic book style art and incorporated things like TVs and radios that gave updates about the aliens getting closer. We used effects like panning across magazine racks to give a snapshot of what's going on in the world. To remind the player that while they are in excel spreadsheet they are doing something that is important and it affects the outside world. We even themed the tools so the learners could see the progress of the machine, called the Alien Fossilizer, which the factory built. After the project was completed, everyone enjoyed the playtests even though anyone in the lab would have said what we created was not a game. If I had a takeaway from the whole experience it would be that a game isn't always the answer, and a game is not the only thing that can be fun or effective.

ERIC CHURCH: Game Designer Breakaway Games

I'm Eric Church of Breakaway Games and the University of Baltimore. Mine actually is the scary story, there's no success here so far. There may be some time in the future. We responded to a proposal that was a request to teach paramedics, and to teach high school students STEM. The idea was to have people be paramedics, and when they encounter something that was a physiological system, it would be a simulation that would give you high-level abilities. We made the mistake of asking teachers what should we make the objectives. They were all anatomy and physical systems. There was no game in any of them. If you take objectives like this, try and cram game ideas into it, all you're doing is making a boring process take even longer. It became trying to steer the educators toward our process, not just things that were their objectives. It's not done, so it's a bit scary.

ROGER TRAVIS

One thing I need to get out there is that learning objectives are verbs, they're not just nouns. I think it's what a lot of us were talking about is trying to figure out what the best verb is that will encompass this taxonomy and get something to be more playable. My little story is I had a combat mechanic in an RPG, you try to guess someone's secret passage. What I wanted them to do was recognize it and know that this was from Oedipus Rex again they would know what it was from Oedipus Rex. It was much better in the end to make this a tabletop RPG, so students could discuss directly, and that got at the analysis we wanted.

BRENDAN TROMBLEY: Game designer: Institute of Play

My story is related to changing learning objectives, but it's also about changing the goal of your game around the learning objective. It's about math and formulas. My job is to work with the teachers to make games that work inside of the classroom. I was working with a teacher who was making Pythagorean Theorem games. We were trying to get across the grid, so you had to make diagonal movements--manage your resources to move. But it became apparent that it's not fun to sit around and do the Pythagorean Theorem while three other students sit around and wait for their turn.

So we totally reframed the game, as a pre-activity, not about the Pythogorean theorem directly . You're making estimates and seeing how accurate those estimates are, with the idea of creating a vacuum for the learning. Once the teacher could teach the theorem, the kids could say – here's the missing piece I could have used in this game.

When the kids were playing it, they were all, “Oh we can use the Pythagorean theorem for this!” it was moved from a teaching game to a pre-activity.

SCOT OSTERWEIL

It’s probably worth mentioning that everyone in this room should be reading ‘Preparation for Future Learning’. Most games are that, they’re not the product of ...It creates the interest or the gap, it is learning, but it is also preparation for the formal learning that comes later.

BARBARA CHAMBERLIN: New Mexico State

I’m Barbara Chamblerlin with New Mexico State University’s Learning Games Lab. several speakers have noted an unfortunate trend, where — if the learning objective is to learn X, designers create a game where players practice doing X. It’s one way to go, but it may not really be where the magic is. Sometimes, the most effective game is one where, if the player has to be able to do X, they first have to do A or B instead. Even better would be for the game to place learners in an environment where they discover on their own that doing X is the best solution.

The trend isn’t just on the part of game designers who create games, but sometimes our end users, or our gatekeepers, assume that games must look like what they are supposed to teach. Therefore, if they want kids to learn multiplication, they believe the game should be full of multiplication equations. The problem with this is that if a game helps the learner in a more gradual or conceptual way, it can be difficult for the gate keepers to understand how this approach leads to learning.

For example, one of our Math Snacks games is designed to help learners with concepts in pre-algebra. In “Gate”, players build numbers in a variety of different combinations, using place values. You can see the place values on screen — the ones, tens, hundreds, hundredths, etc. When some people look at it, they think it is a game to teach place values: it isn’t. Until they’ve played through several levels, they don’t see how it really helps kids construct numbers in different ways.

We’ve learned the need to communicate what the game is and particularly, how it leads to learning. As we design games that lead to learning in new ways, in more conceptual or inquiry driven ways: we also have a responsibility to communicate to teachers and parents how and why that learning works. We want our gatekeepers to expect more in games than straight content delivery or practice, so we need to help them see how learning can happen in ways that aren’t immediately obvious.

FRANCISCO SOUKI: Game Designer, Schell Games

I’m Francisco Souki and I’m a game designer at Schell Games. Something we found that helps a lot was our transition from educational to transformational experiences. Project goals are usually communicated as verbs - and the verbs are tied to the game mechanics, so it’s mainly the responsibility of the developer to figure out the semantics of the goals. Our approach is more about player transformation: what does the player look like before and after the experience? The client is usually great at answering that question, and we craft the goals as the project progresses based on their answer. HaH

Hall of Failure

Are We Washing Poop?: Unintended Consequences in Educational Game Design

Christine Bediones, Camille Macalinao, Kal Benjamin McDowd, Katerina Schenke, Cathy Tran, AnneMarie Conley, University of California, Irvine
xbediones@gmail.com, cmacalin@gmail.com, kbmcdowd@uci.edu, katerinaschenke@gmail.com, ctran27@gmail.com, ampm@uci.edu

Abstract: What game developers and researchers know about what makes games enjoyable for children does not always transfer well to educational contexts. This paper highlights potential pitfalls that may arise when creating a game that attempts to integrate learning and fun using a case study of *Down With Food*, a game that teaches upper elementary school students about the digestive system. We employed game mechanics and game design usability heuristics in our development of this iPad application. User testing revealed areas in which applying general game principles to an educational context created concerns, particularly with respect to the effects of schemas, visual misrepresentation, and usability issues. In detailing these unintended consequences, we hope to spur productive discussions about how to address the challenges of bridging the fields of game design and education.

Introduction

“To make this game ‘scientifically accurate’ we would be making kids watch blobs of food change in imperceptible ways for about 18 hours.” -Neil Young, game designer, *Down With Food*

Education and entertainment are typically ascribed the “oil and water” metaphor because they never quite seem to mix well, evidenced by mountains of neglected educational games that reek of fake fun (Bruckman, 1999). Children rarely reach for games that are too heavily saturated with “learning” concepts because they prefer their diversion time to be a break from the hours spent at school. Whether this is an issue of educational content that simply cannot be made fun with complete accuracy, as suggested in the quotation highlighted above from our game designer, or the ever-developing understanding of what it means to fuse learning and fun into one game, it is our goal to shed light upon strategies that game developers can use to leverage game mechanics in education. Deviating from traditional educational games that treat “fun” as separate and secondary to learning, our design decisions were largely geared toward leveraging the aspects of games that make them appealing and enjoyable, and integrating those aspects into the development of educational content. Through iterative user testing and applying findings from research in cognitive and educational psychology, we have gained insight into the nature of design challenges that occur when trying to truly fuse fun and learning into an educational game. After studying and implementing specific elements of game-based design, such as leveraging the affordances of the iPad and understanding the gaming experiences children have, we present a case study on the development of *Down with Food*, an educational mobile app created to teach children ages 7-12 about the human digestive system.

We created *Down With Food* to teach young children about the digestive system through a series of mini-games that are each based on attempts to apply popular game mechanics to an educational context. As a multidisciplinary team, we often encountered disputes among our educational researchers, designers, and programmers when trying to negotiate seemingly separate goals. Our conversations have been crucial to understanding the complexities involved in making an educational game.

The first consideration in negotiating a scientifically accurate depiction of biological processes and transforming it into a fun, playable game was our deliberate use of fantasy. While fantasy elements may detract from learning aspects if children are unable to differentiate biological processes from gameplay, creating a virtual reality is a key element to get learners immersed in game play. In *Making Learning Fun*, Malone and Lepper (1987) produced a taxonomy identifying four categories of individual motivation responsible for the positive effect created by computer games. Along with challenge, curiosity, and control, this taxonomy includes incorporating the element of fantasy (Malone & Lepper, 1987). To incorporate fantasy elements into *Down With Food*, we deliberately used “tower people” as enzyme launchers that players can drag and drop along the lining of the small intestine (see Figure 1). Allowing players to place multiple towers from which to release enzymes in the small intestine mini-game is not scientifically accurate because there is only one duct from which enzymes are released within the small intestine. Prioritizing gameplay was deemed more important in garnering players’ interest. Additionally, knowing which elements of the game learners take with them needs to be explored further. Our team felt it was more important that players understand enzymes are needed to absorb nutrients than the fact that these enzymes are all released from one duct at the beginning of the small intestine, instead of from many depicted by the “tower people”.

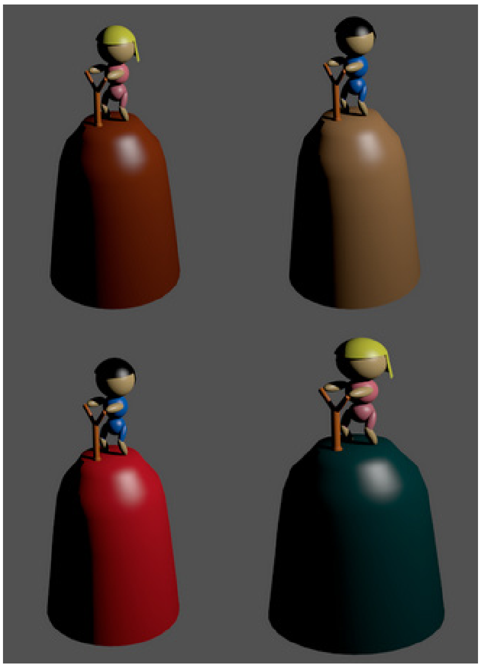

Figure 1: The enzyme “tower people”.

Down With Food: How it’s played and what it teaches

To find a balance between education and entertainment, we looked at game design principles followed by popular games to determine which principles to consider when creating our own game. A game that implements intrinsic integration is one in which the designer integrates the subject matter with the game idea (Kafai, 1996). Because there is currently no definite method for evaluating the effectiveness of intrinsic integration in a game, we designed our game based on general usability principles proposed by Pinelle, Wong, and Stach (2008), who describe ten design heuristics after searching through online reviews for various video games. From these ten principles, we based most of our initial design on those that focus on game play mechanics, instead of those that focused on customization and artificial intelligence.

To study intrinsic integration and implement Pinelle et al.’s (2008) usability design heuristics, we used *Down With Food* to observe the effects of game design in user testing sessions. *Down With Food* contains a collection of mini-games that explore how the digestive system works by allowing players to follow the process from when the food enters the mouth until it is released from our bodies. Each mini-game focuses on a different organ involved in the digestive process. Our initial focus is on the small intestine mini-game, which imitates the design and gameplay of Tower defense games, a subgenre of real-time strategy games in which players typically place static units to defend against mobile enemy units attempting to traverse a game map. After considering several different genres of games, we decided to adopt the Tower defense paradigm because of its popularity, and the fact that its gameplay most closely matches the processes that occur in the small intestine. The interaction between the enzymes and the food passing through the small intestine is similar to that of towers and incoming waves of enemies in many traditional Tower defense games.

In the small intestine mini-game, players place enzyme towers that release enzymes (for fat, protein, lipids) that break down the food as it passes through the small intestine. Each food blob has to be in contact with certain types of enzymes to be broken down and have the nutrients contained within the food blob absorbed by the villi located throughout the small intestine. In addition to these gameplay mechanics, *Down With Food* provides persistent health and nutrient counts to show the player’s status throughout the game. The health count reflects how healthy the character is. If food is not completely broken down, then the character’s health decreases. The nutrient count keeps track of how many nutrients have been absorbed after breaking food down by applying enzymes to food blobs. Certain amounts of nutrients are needed to build certain enzyme towers. Through this game, our goal is to demonstrate the process of enzymes breaking down the food into nutrients, which are then absorbed by the villi.

Application of Game Design Usability Heuristics

We based our mini game on four of the ten usability design principles described by Pinelle et al. (2008). The first principle we considered is providing “consistent responses to the user’s actions” (Pinelle et al., 2008). Our design allows players to drag each tower and to place the tower only on the lining of the small intestine. The second principle we implemented involves “providing controls that are easy to manage and have an appropriate level of sensitivity and responsiveness”, by having the towers light up when they are dragged to a place where they can be set (Pinelle et al., 2008). As soon as the tower the player’s finger is dragging is directly on top of the lining, the towers can be placed there. The design is sensitive and makes sure that the towers are dragged and dropped exactly where the lining in the game is located. The third principle we use in our design is “providing users with information on game status” (Pinelle et al., 2008). We show nutrient and health status counts; the health status to display information to players about how healthy their character is throughout the game, and the nutrient count to display how many nutrients they have available to build additional enzyme towers. The last principle we considered and implemented in our mini-game is “providing instructions, training, and help” (Pinelle et al., 2008). Before players can play the mini-game, players are first shown instructions that describe which food blobs should be broken down by which enzyme towers, to ensure that players understand how the gameplay works. The other six principles described by Pinelle et al. involve heuristics for games that involve more plot-based gameplay, rather than for mini-games like ours. Hence, we did not take these principles into consideration while designing our game.

Insights from user testing: Unintended consequences

During our user testing sessions, we had seven children, between the ages of 4 and 10, play our small intestine mini-game. During gameplay, we asked each child to describe his or her own thought process out loud. After they finished playing the small intestine mini-game, we asked the participants what they thought was happening in the game and whether they thought the game was fun.

Schemas

Pre-existing knowledge and perceptions that players have about a game can affect how players learn to use the game and how players understand what is happening in the game. In our small intestine game, we wanted to show that the towers shoot enzymes at the food blobs to break them down and that nutrients get absorbed by the outer villi projections afterwards. Tower defense games typically ask players to strategically place towers to ward off oncoming enemies. In our game, players need to place towers along the small intestine and shoot enzymes at oncoming food. The oncoming “enemy” in our game is actually an “ally” for survival. To our surprise, many children were not able to grasp that concept. For instance, one child explained to us that “the towers are attacking the food because the food is something bad,” a statement that would be completely in line with mechanism upon which most Tower defense games operate, but is clearly not true in the case of food breakdown within the small intestine. One possible explanation for this misconception is that the goal of most Tower defense games involves strategically placing towers in order to attack passing enemies and defeat them. Children who might have previously played Tower defense games, or are familiar with them, have developed a schema that Tower defense games involve attacking or killing waves of enemies, so when playing something new that mimics the design of such games, they associate the Tower defense game schema with the new game.

Visual Misrepresentation

Graphical representations have nuanced ways of influencing children’s’ interpretation and understanding of educational content in games. For example, in *Down With Food*, when the towers hit the food blobs, the nutrients to be absorbed by the villi were represented as several glowing colored dots to demonstrate that they were broken down. As one child was playing, she noticed these dots (see Figure 2). When asked what she thought was happening, she stated that “[the enzymes] were washing the poop”. When asked why she believed that, she commented that the green dots looked like soap suds, which we did not intend. What we designed to help players understand that the nutrients are broken down in the small intestine was instead perceived as washing. As previously discussed, many children described the scene as the towers attacking or killing the passing food blobs. One child even described it as “the towers eating the food blobs.” Along with the schema most players have of Tower defense games, the graphics in our mini-game show the enzymes as bullet-like projectiles being shot from the enzyme towers. The food blobs are seen as enemies destroyed by bullets from the towers, with the towers as the “good guys” and the food as the “bad guys”. These examples demonstrate how visual misrepresentations, combined with schema effects, can cause unintended misconceptions when trying to integrate learning and fun.

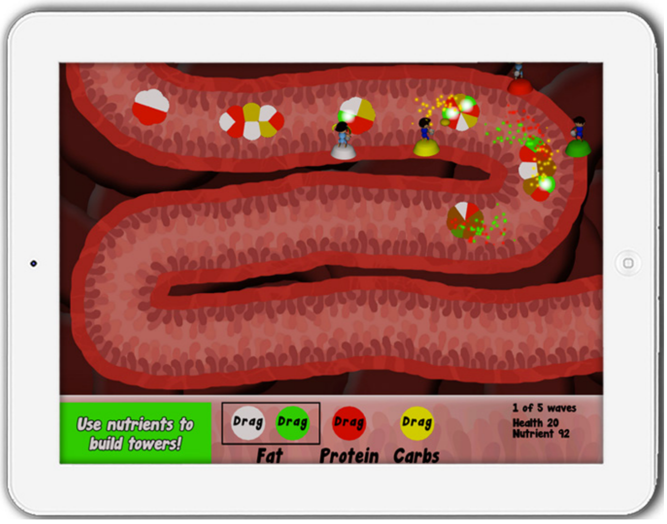

Figure 2: Visual effect produced when enzymes hit food blobs, breaking the food down into nutrients.

Usability Issues

During our user testing sessions, we discovered that, even as we based our game on Pinelle et al.'s (2008) usability heuristics mentioned above, we still encountered some usability problems. We found that during the testing sessions, in many cases the game did not give enough allowance for children to place the towers. Often, the children would drag a tower to a position just a short distance from the lining of the small intestine, and would release the tower, thinking that the tower could be successfully placed. However, because the tower had been placed in a position slightly off the intestinal lining, the tower would fail to be placed, and the player would be forced to try again. This corresponds with Pinelle et al.'s (2008) principle of the sensitivity of game controls, as well as the principle involving consistent responses from the player's actions. Because children are still developing their motor control and hand-eye coordination, they are unable to keep their finger on the same spot for an extended amount of time. As such, considerations that include understanding child development need to be incorporated into design. Also, our controls were too responsive and the allowances for not placing the towers directly on top of the lining affected gameplay by forcing the player to sometimes try placing towers more than once. Furthermore, the point system that relays nutrient and health counts went unnoticed by the players, who didn't understand why they occasionally could not build new towers. While we did follow the usability principles proposed by Pinelle et al. (2008), we learned that game design for a younger audience should allow for more room for error. This demonstrates that considering child development is very important in game development and that the age of the player can result in different responses to different designs. As such, appropriate scaffolds must be integrated into the game.

Future Design and Directions

How can we change the Tower defense schema to reflect that enzymes are breaking down the food and allowing the body to absorb nutrients, rather than allowing the misconception of towers shooting the food to continue? First, we can provide more visual support to lead learners into understanding the intention of our graphics. Designing graphics to more accurately portray what is happening in the small intestine, such as modifying the visual effects produced when the enzymes start breaking down the food can help. Instead of understanding our towers as warding off an enemy, they should come to understand our towers as aiding in the digestion of food. Furthermore, sounds with a more

fantastical element can be used to portray the beneficial process of breaking down the food in the small intestine, further reinforcing the benefit of absorbing nutrients.

More sophisticated methods of evaluating games based on intrinsic integration are necessary to progress in the genre of fun educational games. While intrinsic integration is a theoretically grounded solution to the problem of fusing learning and education, it is difficult to evaluate because best practices around its implementation have not yet been established. In order to create a dialogue around the validity and plausibility of implementing

intrinsic integration in games, we will present findings from further user testing sessions as a starting point for the larger conversation.

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Awe and Blunder in Science Games

Marjee Chmiel, Smithsonian Science Education Center, ChmielM@si.edu

Abstract: From 2008-2010, the author produced dozens of science education games and interactives at National Geographic's The JASON Project. Created in collaboration with scientists from numerous agencies and universities, these games are currently being played in classrooms across the globe. Many of these games have gone on to win awards and several are currently available for free online. These successes, however, were purchased with fruitful mistakes. This paper presents the most productive failures during those two years and highlights guiding principles that informed more successful subsequent projects. I focus on science games in particular with the hopes of initiating a dialog about issues specific to science games and others relevant to educational game design writ large.

A Collection of Science Games

This is a discussion of lessons learned in developing a portfolio of science education games targeted at middle school age youth designed primarily to be played in formal education settings. These games were developed as part of a standards-aligned science curriculum with The JASON Project, formerly a subsidiary of National Geographic. All of the games discussed in this paper have eventually gone to "market" (free, and online at the time of release) and have been used by teachers and students. All of the games were created in collaboration with a single developer, Filament Games. Some games have gone on to receive industry recognition. While many games continue to be played and used in classrooms, others have not stood the test of time. This paper connects the experiences of the author to theory and research with the goal of documenting and initiating a dialog on best practices in science education game design. I offer the following ideas as evolving theories developed in practice to that dialog.

Narrative-Based Games: Worth the Trouble?

Our first project as a team was to design "Mission 4: Hawaiian Islands" for *Operation: Resilient Planet (*The JASON Project, 2008*)*, an underwater ecology game. "Mission 4" was based entirely on a research expedition by marine ecologist Enric Sala. Dr. Sala's research explores relationships in near-pristine ecosystems off the coast or remote Hawaiian atolls. Sala's research flipped the widely accepted understanding of apex predator and prey relationships on its head (Sala et al., 2005) and provided increased urgency for the maintenance of marine biodiversity. "Mission 4" was unique among existing science video games as it was designed to be an adventure game that walked players through the actions, choices, and arguments that Sala went through in his groundbreaking research. In other words, the game allows students to play out a research paper then in press for publication in *Science*. In this respect the game was successful at telling a story and allowing students to play through a scenario modeling a type of authentic inquiry and scholarship (Chmiel, 2009). Research in other academic areas, such as writing (Dickey, 2006) suggests that 3D environments with game-play driven by narrative provided "a cognitive framework in which players can identify and construct casual patterns which integrate what is known with what is conjectural yet plausible within the context of the story" (p.2).

This is to say that at the individual, student level, this game design had a lot of promise. However, when we move the unit and context of analysis from student to classroom, several drawbacks emerged. A developed narrative with naturally integrated content meant that game play could take anywhere from four-six hours for middle-aged students and likely even longer for younger students. This was difficult for teachers to integrate into the classroom context, where they often have as little as 20 minutes in the course of a week to focus on science content. Many teachers expressed interest in the game, but would point out that their pacing guides address the same standards that the game addresses in a fraction of the time.

Narrative games always present game designers with a challenge to balance story-telling and player agency (Reeve, 2009). Beyond this, narrative driven games require game designers, programmers, and writers to hard-code many of the meaningful and interesting choices (Rollings & Morris, 2000, p. 38). As Schaller suggests, "this approach serves both story and gameplay poorly, as it forces players into increasingly meaningless choices simply to keep the number of story branches manageable" (2011). The problem of managing story branches is especially poignant when creating educational games, which are often done on very small budgets compared to commercial games.

As a narrative, Mission 4 of *Operation: Resilient Planet* did a few things very well. It provided an immersive experience and served as a virtual "field trip" to an exotic biome. It allowed students to walk through the evidence and argumentation of one specific scientist's research project and much of the success of doing this particular game as a narrative likely rests in the fascinating and kid-friendly research conducted by Sala. We were able to document, via game experience, this cutting-edge ecology research at the expense of time (the game took more time than most teachers could allot) and at the expense of authentic choice. We ended up dividing the full game experience into standards-aligned fully playable "mini-game" versions and found great success with these. Mini-games aligned better with the tempo at which teachers needed to hit their learning objectives and also solved the time problem. We also found that on this smaller scale, players' choices seemed more meaningful. In the end, the narrative approach to the game seemed like "more game" than what teachers wanted and what we found sustainable as a non-profit. As we moved on to other curricula, these findings informed our planning.

Working with Specialists

Scientists can lend wonderful expertise to game development. In our game development, we worked with a number of leading scholars and specialists in energy, ecology, and geology. These specialists allowed us to bring cutting edge research findings into our games and brought perspective and rigor to our games that would be otherwise impossible to capture. But it is important for specialists, content writers, artists, game designers, and project managers to work towards a common understanding of the end goal.

Note that most instructional design projects refer to this role as the subject matter expert and I don't do that here quite intentionally. Specialists give unique insight to high-level scientific concepts, but these are often beyond the scope of K-12 learning standards. For this reason, I consider the subject matter expert to be a hybridized role (rarely occupied by one single person) of a science topic specialist and a person with a more generalized background in science education or science curriculum. For this reason I want to be careful to distinguish the person with the advanced science knowledge and the person who can integrate that subject knowledge into the context of school curriculum.

We found that one of the greatest challenges in working with specialists was effectively communicating what they saw as the necessary elements of their field to bring into the game. After all, specialists acquire a very specific way of seeing the world, frequently with complexities and nuances that our untrained eyes miss. Games, on the other hand are, by their nature, models of complex systems which highlight a few complexities in game mechanics and ignore many of the other issues in order to focus attention on particularly significant content elements and relationships. The following were some useful guidelines we developed in working with science specialists in developing games:

1. *Partner with scientists who are actively involved in science communication or outreach.* Specialists with a demonstrated record in working toward public understanding are often sympathetic to the nuances of communicating with a K-12 audience and have cultivated skills in relating to lay audiences.

2. *Be clear about the learning objectives your game is designed to target.* Have these objectives prominently displayed and to keep the conversation on target.

3. *Ask the specialist: What are three things you wished everyone understood about "X"?* Invite the specialist to establish content priorities.

4. *Decide ahead of time which assets, and to what extent, the specialist is part of the feedback cycle.* Build these into the project timeline, allowing specialists an ample timeline to weight in.

5. When soliciting feedback from a specialist, be explicit about what aspects you are looking for which you require feedback (i.e., is the fish anatomy correct? Is the monk seal moving in a realistic manner?) and provide the specialists with copies of learning standards you are seeking to address, to aid them in contextualizing their feedback.

Scientific Explanation, Mechanisms, and Mechanics

A goal of our games was to facilitate student understanding of complex scientific phenomenon and utilize non-game curricular materials to enhance student practice of scientific explanations. Currently, much of what passes as "scientific explanation" in classrooms is more truly scientific description as textbooks and curricula often use stated laws to describe a phenomenon. In other words, to say that a barometer goes down because air pressure has increased is merely a description, not an explanation. Rather, to provide a description of the molecular mechanisms that link the two phenomenon is a true explanation. Rigorous scientific explanations require some examination of mechanism, where by "mechanism" I mean "an *account* of the makeup, behaviour and interrelationship of those processes which are responsible for the regularity [of a scientific phenomenon]" (Pawson & Tilley, 1997).

Games provide a unique opportunity to do this because they can provide on-demand information, or layers of information that are de-coupled in the real world. For example, in teaching kinetic and potential energy, it is common to get students to build a series of ramps and observe the motion of something along these ramps. At The JASON Project, our game *Coaster Creator* (The JASON Project 2009) added an additional layer of algebraic equations on top of the visible phenomenon. Students were able to see the relationships of the algebraic variables in real time with the physical phenomenon. Games such as *Coaster Creator* make visible the causal mechanisms of a scientific phenomenon in a way that is impossible without this toy like digital environment. This emphasis on causal mechanisms is valuable because it allows students practice and take ownership of deeper levels of scientific explanation in the relationship between an equation and their tacit understanding of forces and motion.

To be sure, games in physical science or statistics-ruled aspects of life sciences or science policy lend elegant mechanistic explanations. Here we found opportunities to weld clever game design to mechanic, and these games yielded not only massive amounts of play numbers as part of classroom activities, but noted that many students logged in to play on their own during the evening and even on weekends. Discussions of increasing their scores took place on student discussion boards on the JASON website, as well as external websites such as Yahoo answers (Chmiel, 2012).

Don't Make Navigation A "Thing"

During development of a downloadable3D game in which players primarily piloted a watercraft, designers went back-and-forth over ideas about how to manage controls. A typical convection for this navigation on a PC is to use the W(forward) A(left) S(backward) and D(right) keys. In player testing, we found that students had no trouble with this navigation. Teachers, on the other hand, were frustrated by the WASD navigation. At first, we had a hard time convincing teachers that WASD was not simply a random assignment of characters with no rhyme or reason. In addition to WASD, we required depth navigation to maneuver the craft throughout water. This required additional use of the arrow keys, to be used in conjunction with WASD and various hotkeys to perform key actions. All of this was presented to first time players in an optional in game tutorial that took less than five minutes. With professional development and encouragement, we were able to convert most teachers into WASD believers. However, a small percentage of teachers decided that navigating the 3D environment would simply pose to be too challenging or too time consuming to learn for students and even a brief tutorial took too much time for teachers with little to spare.

This presented us with a dilemma. On the one hand, the 3D underwater graphics were beautiful and allowed for authentic models of marine life. We were able to bring students a real sense "being there" in the Hawaiian Islands. On the other hand, the environment demanded navigation that was unattractive for some teachers. We decided to abandon 3D environments and demanding navigation in subsequent game development and consequently had far better uptake and reception among teachers and students. Those games were developed to be accessible via Flash and allowed us to better standardize welcome screens, basic user-interface style conventions, and in-game tutorial help.

Navigation and usability in games is well documented at the early-childhood level, but there is a dearth of research when it comes to navigation and usability for the older child, particularly in considering limitations of a full classroom of children playing together (Muehrer, Jenson, Friedberg, & Husain, 2012). This is an issue I would like to see the Games, Learning, and Society community pursue in future research as our field continues to mature.

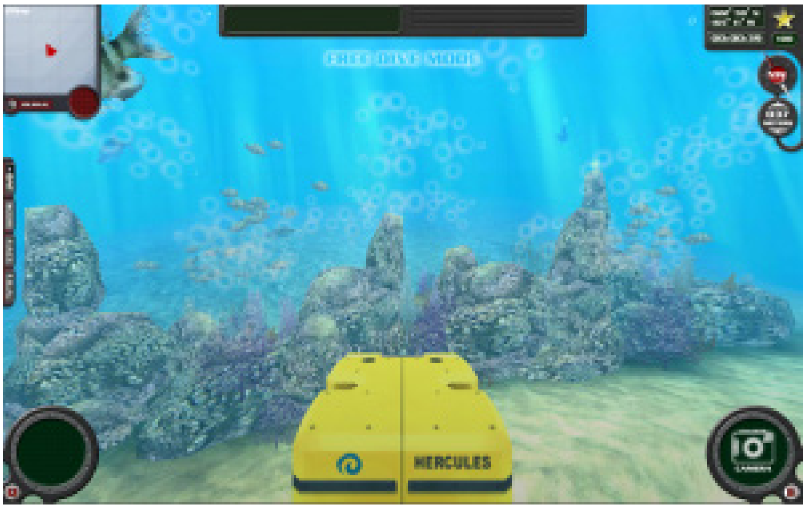

Figure 1: Teachers loved the underwater environment, but many struggled with the navigation.

Embracing the learning standards

Some topics in science are very sexy and seemed ripe for great game play. For instance, blowing up asteroids, settling Titan, Saturn's largest moon, or trying to out-survive other dinosaurs during the Jurassic are all fun ideas this author would love to play, but would not produce in a formal education project. Why? I'll forward the following proposition: If you are looking to develop an educational science game, you have two options 1) develop a game about whatever science topic you want and create a marketing plan around home/ recreational play or 2) consult national and state standards to get a sense of what topics are taught at particular grade levels to specific learning objectives. No matter how fun and rigorous your game about T-Cells is, few middle school students will play it during class-time. That is because immunology is sparse in most school curricula.

Maximizing the appeal of an educational game to teachers and schools helps secure their place in curricula and by securing the place of these games in the school day maximizes students' opportunities to access these games. Games with more specialized themes might be played as part of an after-school program or as an enrichment activity, but fewer students have access to these outlets. Furthermore, Next Generation Science Standards advocate for the same types of practices supported by games such as scientific argumentation (Steinkuehler & Chmiel, 2006). Designers looking to design science games at the K-6 level should also remember that science is often neglected at that level in favor of math and reading standards. These designers would do well to be mindful of The Common Core standards and seek literacy and math applications as part of their learning objectives. Many of these standards specifically call for the application of literacy and math to real life problems and situations. A vital strength of digital-game based learning is its ability to situate children in real-life applications (Gee, 2003) thereby underscoring the unique role games can play in bringing meaning and value to learning standards.

While public education is by no means an equalizer when it comes to digital access, it is the closest thing we have. For this reason, I am a proponent of working closely with teachers and understanding their needs, particularly when it comes to working within the learning standards.

Transgressive Play, Point of View, and Learning Science

Finally, I want to address the role of transgressive play in science games. Good educational game design supports children's desires to break the rules or transgress (Wilson, 2009). Games can do this by intentionally building transgression into the game by, say, inviting them to crash roller coasters or "design" simulated invasive species. Or game developers can design a game that anticipates that children will want to push the game boundaries by, for example, rewarding them with a unique or silly find at the edge of the game world. Considering some of the other pedagogical priorities of science education discussed in this paper such as scientific argumentation, scientific explanation, and the engagement in the practice of science can make these opportunities for transgression rather tricky.

In the case of the crashed roller coaster, the lesson plans surrounding the game promoted engineering practices whereby students married design and mathematical thinking to prevent future crashes, but the transgression design of the invasive species presented us with a dilemma. If a child designs an invasive species, that child may learn a great deal about ecological niches and survival of the fittest for his or her designed species. In *EcoDefenders* (The JASON Project, 2010), we wanted children to have a better understanding of a variety of ecological niches and we also wanted the children to understand how an ecologist comes to ascertain the impact an invasive species has on an environment. As such, the point of view of the invader becomes restrictive and obscures critical learning standards. The player learns *about* science, but the player doesn't *do* science.

For this reason, Ecodefenders was designed so that players were required to shift their point of view from the "first person" of natural selection (embodied as the invasive species) to that of a scientist gathering data about the animal. When the transgression of a game centers on the subject of a learning objective, the game loses its potential as an epistemic frame (Shaffer 2006), and it is this epistemic frame that is at the heart of authentic inquiry (Chinn & Malhotra 2002).

Conclusion

By designing, developing, play-testing and launching as many games in a 3-year span, The JASON Project and their partners Filament Games learned a great deal about producing high-quality, popular, useful and used science games. By enumerating our findings in this paper, it is my hope that the Games, Learning, and Society community can discuss academic-domain specific game design challenges and grow our understanding of the unique design challenges faced when the classroom, not just the individual player, becomes the unit of analysis. Various game mechanics highlight and obscure scientific ways of knowing in different ways. We've only begun to explore the ways in which mechanics and epistemology can work together. In a new era of science standards, there has never been a better time to make the case that digital games can magnify these standards beyond what traditional curricular resources bring to the table.

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The Inevitability of Epic Fail: An Investigation of Implementation Problems Associated with Technology-Rich Research Innovations

Stephen T. Slota, Michael F. Young, Roger Travis, University of Connecticut
stephen.slota@gmail.com, Michael.f.young@uconn.edu, roger.travis@uconn.edu

Abstract: Reviewing large-scale attempts to introduce new technology-based approaches to instruction yields many instances where researchers have used contemporary learning-science research and theory to design innovative, technology-based curricula that show substantial benefits to important instructional variables. Crucially, however, these results arise only when the project originators have close and direct involvement with teacher training and implementation. With evidence for limited long-term success, both educational psychologists and practicing educators must ask: "Why do technology-rich research innovations fail once researchers are no longer directly involved?" The authors aim to address this question in a way helpful to game-based learning researchers by presenting an example of failed implementation of a learning game paired with follow-up research on other instructional tools and methodologies. We propose three reasons why such innovations fail: 1) Fatal Mutation Due to Assimilation; 2) Loss of Fidelity; and 3) Failure to Thrive. Recommendations for addressing these issues follow.

The Inevitability of Epic Fail

Looking back on large-scale attempts to introduce new approaches to instruction, it is not uncommon to identify instances where contemporary learning science research and theory have been instantiated into innovative, technology-based curricula with empirical research findings that evidence substantial benefits to important instructional variables (e.g., student-side variables – test achievement, self-regulation, course completion, motivation, engagement – or teacher-side variables – content knowledge, wait time, professional development, collaboration). Crucially, however, these results only arise when the project originators are closely involved through teacher training and implementation. Once they pull back, the original instructional motivations, objectives, and underlying theories are often lost. Notable among such "new" approaches are Logo (Papert, 1980), *The Adventures of Jasper Woodbury* (Cognition and Technology Group at Vanderbilt [CTGV], 1992), and Apple's Hypercard. Many projects in the realm of game-based learning have experienced a similar fate, including a variety of educational video games (Honey & Hilton, 2011; Young et al., 2012), games for non-academic instruction (e.g., Aronowsky, Sanzenbacher, Thompson, Villanosa, & Drew, 2012; Sylvan, Larsen, Asbell-Clark, & Edwards, 2012), and scholastic tabletop roleplaying games (e.g., Slota, Travis, & Ballestrini, 2012).

With such limited long-term success, both educational psychologists and practicing educators must ask: "Why do technology-rich research innovations fail once project originators are no longer directly involved?" We address this question through a worked example of failed implementation paired with follow-up analysis on other instructional tools and methodologies. More specifically, we propose three reasons why technology-rich educational research innovations fail: 1) Fatal Mutation Due to Assimilation; 2) Loss of Fidelity; and 3) Failure to Thrive. Recommendations for addressing these issues follow.

What Game-Based Learning Researchers Can Learn From History

Technology integration efforts intended to dramatically change American education have a rather checkered implementation history. Indeed, there is still debate over the extent to which even simple technologies like calculators and word processors have meaningfully affected school classrooms, nevermind more advanced tools such as geospatial mapping software, programming languages, 3D avatar-based virtual worlds, scientific modeling environments, and online video series used to "Flip" classrooms. The rise and subsequent fall of these technologies has provided researchers with several notable examples that exhibit how no amount of time, effort, and money has been able to sustain long-term change. The following serve as indicators of how the complexity of innovative technology implementation can override both good ideas and intentions:

Logo

Based on Papert's exploration of constructionism-based learning environments, Logo was developed in 1967 as a programming language that made LISP-like artificial intelligence programming accessible to elementary education students through graphical representations of a small, moving turtle. It received widespread research and acclaim by teachers at the time of its implementation, but rather than acknowledging a new paradigm for student learning, school environments chose to assimilate Logo into their tried-and-true method of education: direct instruction. Once the developers and researchers left the school environment, classroom teachers defaulted to teaching *about* Logo in place of teaching *with* Logo. As a result, students were ultimately led to memorize Logo programming commands (e.g., FD50 RT90) from teacher-generated worksheets. After peaking in the mid-1980s – largely due to the development of the Apple II computer – most of Logo's 197 compilers/interpreters fell out of educational use. After peaking in the mid-1980s – largely due to the development of the Apple II computer – most of Logo's 197 compilers/interpreters fell out of educational use despite numerous research studies showing the benefits of students learning with and about Logo the way Papert envisioned. This led Papert (1993) to apply the Piagetian notion of assimilation to the entirety of American schools and conclude that large scale school reform was largely impossible (Papert, 1997).

Jasper

Vanderbilt University's Jasper Woodbury videodisc series was a professionally filmed video production designed to support middle school mathematics and problem solving. Drawing on contemporary learning theories of situated cognition and anchored instruction, these videos were meant to provide an authentic learning context prior to and in conjunction with other instruction. However, fearing that students were unprepared to handle the series' outward complexity, many teachers chose to educate their classes using the stories as post-instruction word problems rather than a context for inquiry-driven learning. Once the program's researchers ceased their direct interaction with participating educators, the videos became mainly capstone activities, relieving them of any potential they once had for providing an authentic context for learning. The migration of videodisc to DVD coupled with rapid antiquation of the series' content (e.g., the price of gas as part of the calculations) further sealed the program's fate. By the late 1990s, Jasper was almost universally shelved.

HyperCard

HyperCard functioned as the framework from which several other learning technology innovations were based. Teachers and subject matter experts collaborated to create classroom tutorials, including dribble file data for assessments and interactive controls for videodisc players. However, rapid technological advancement during the 1990s rendered HyperCard obsolete, inadvertently categorizing all related instructional innovation as outdated and irrelevant. Work derived from thousands of HyperCard programming hours was lost or abandoned once Apple stopped supporting the system in favor of HTML and Java, and with no simple migration path, HyperCard vanished from the classrooms its creators hoped it would revolutionize. The moral: technology comes and goes so quickly that technology-specific innovative pedagogy may be doomed to fail or eventually to fade.

Operation BIOME

In April 2012, approximately 1,500 educators and administrators were contacted with an offer to utilize a year-long, alternate-reality game (ARG)/roleplaying game (RPG) biology program, *Operation BIOME*, beginning in the Fall 2012 semester. Each teacher received a school-specific email that described the nature of the project, incentives for participating, and other pertinent participation information. Of those who were contacted, 17 expressed interest, 10 responded to additional inquiries regarding their participation, and five followed through with training and implementation. Six more teachers opted into the program after witnessing their colleagues utilizing it at the start of the school year. By the end of August 2012, 11 teachers agreed to begin the program with 600+ students spread across 29 class sections in five suburban and urban schools.

Unlike projects that had simply "gamified" science, *Operation BIOME*'s design began with the objectives/standards and used them as a guide for developing the mechanics and narrative rather than the other way around – a design scheme reflective of the top-down approach often associated with strong curriculum development (Bergmann & Sams, 2012). This placed emphasis on the game's ruleset (i.e., how play happens) in order to bring students closer to doing the things real world scientists do: problem solve, think critically, examine existing literature, generate new questions, and, most importantly, collaborate toward realistic, shared goals (e.g., "cure cancer"). Additionally, because the mechanics and narrative followed the same trajectory as state and national standards, the story missions transparently aligned with the information students needed to successfully complete high stakes tests. Put another way, the mechanics and narrative were designed to carry much of the weight usually given to direct instruction, allowing teachers to use the exploratory prompts as an introduction to the class content and class-time for reflection on and discussion of the concepts and skills students discovered outside the classroom (i.e., scaffolding both successes and 'productive failures' in problem solving, critical thinking, etc.).

In an effort to highlight these instructional goals, all participating teachers were extended the opportunity to share in one or more of five one-hour summer training sessions hosted by the researcher via Google Hangout. Training sessions focused on the underlying rationale for *Operation BIOME*, the use of Edmodo, and the integration of *Operation BIOME* with other web-based tools (e.g., Google Documents, the *Operation BIOME* website). The content of each session was cut into a series of short video tutorials hosted on YouTube in order for teachers to review the material again at their leisure. Bi-weekly support sessions were planned for the Fall 2012 in order to bring together *Operation BIOME* teachers with those involved with similar ARG/RPG programs for Latin and Greek language courses. Troubleshooting for *Operation BIOME*, Edmodo, and all related technologies remained available throughout the Fall 2012 semester.

Fueled with a combination of teacher enthusiasm and administrative interest in increasing student achievement, program rollout began in the early portion of September. However, the project encountered a rapid slowdown after the first three weeks due to unanticipated competition for attention with a variety of other district initiatives (e.g., a school-wide science summer reading program, new safety policies, abrupt changes to the biology curriculum). *Operation BIOME* website use dropped dramatically through the middle of October, and by the time December arrived, all 11 participating teachers had either deviated from the designed approach or stopped utilizing the program altogether. Data collection was temporarily halted while the initial research questions were re-evaluated to determine whether or not they could be reasonably addressed with the available information.

A series of short face-to-face discussions revealed that a number of participants had modified the program without researcher approval (e.g., combining units, skipping sections, altering prompts), ultimately resulting in substantial treatment disparity between the experimental and comparison groups. While the teachers noted the helpfulness of on-going researcher support, none were able to commit to biweekly, online follow-up meetings and made clear that altering their typical instruction to fit the "new" model introduced through *Operation BIOME* was not possible given the other time and resource demands being made by their schools. Additionally, they expressed frustration with tracking online student responses and several commented on the relative efficiency of direct instruction over student facilitation.

Understanding Trajectories of Failure

To help game-based learning researchers escape potential failure, we propose that there are three major trends common among the technology-rich educational research innovations described above: 1) Fatal Mutation Due to Assimilation; 2) Loss of Fidelity; and 3) Failure to Thrive.

1) Fatal Mutation Due to Assimilation

Fatal Mutation Due to Assimilation refers to *teacher-generated changes that are fundamentally in opposition to the theory behind the program.* In the case of Logo, constructivist theory dictated that students needed to discover the program language in context, including having younger students know information that older students did not. Once schools deviated from this approach and began teaching the program language with worksheets, students were taught to parrot back decontextualized commands before being allowed to interact with the computer. For Papert (1980), this was akin to Piaget's assimilation but at the school rather than individual level: new ideas were forced into existing schemata (e.g., direct instruction) rather than being applied toward the reformation of an already-existing paradigm.

2) Loss of Fidelity

For the purposes of this discussion, we characterize Loss of Fidelity as *participants doing what designers and researchers intended, but not enough, adding materials that are antithetical to project objectives, and/or watering down required activities to a point where they become ineffective.* In other words, Loss of Fidelity occurs when there is a schism between teacher intention and instructional reality. Dusenbury et al. (2003) explored this precise issue in the context of drug abuse prevention programs, identifying five major measures of fidelity: Dosage, Adherence, Program Differentiation, Participant Responsiveness, and Quality of Program Delivery. We believe this framework can encompass technology-based and game-based classroom interventions equally well.

Dosage includes agreed participation in a daily intervention program but, rather than implementing the set treatment each day, only following through with it once per week or month. This may also manifest as a timing issue wherein dosage chronology is miscalculated or deliberately modified (e.g., in the case of medication, consuming the prescribed drug without food or prior to sleep). Teachers often presented the first episode of *The Adventures of Jasper Woodbury* (i.e., *Journey to Cedar Creek*) following direct instruction about distance, rate, and time. While the video was utilized during the appropriate unit, those who placed the implementation too late along the program trajectory broke their prescribed dosage chronology.

Adherence and Program Differentiation refer to the addition of instructional practices or pedagogies that make a unique program more like a particular pre-existing program. For example, while the researcher may wish to implement a purely constructivist program, a participating classroom teacher might choose to add *Classdojo™* or a similarly designed behaviorism-based program. Such an eclectic approach has the potential to enhance the intervention but also makes innovation less distinguishable from existing programs and may ultimately make it harder to measure the intervention's effects, thereby preventing the researcher from assessing any uniquely added benefit.

Quality of Delivery refers to how well teachers understand the theoretical foundations of a given innovation and dynamically interact with learners in a manner consistent with the design principles. Teaching "in the cracks" (i.e., in a live classroom where interactions cannot be scripted) requires implementers to "fill" non-program activities and discussion with information and responses that are consistent with designer's theoretical framework. This bears a direct relationship to Participant Responsiveness – the way instructional interventions are received by the target audience (i.e., both teachers and students). Because instruction is intended to induce particular learning experiences and interactions, miscommunication or ineffectual implementation may lead the audience to miss the intervention's situated value. When elements like Dosage (e.g., how much Jasper or Logo instruction is needed before measurable changes in math achievement can be expected) conflict with school scheduling or administrative initiatives, Quality of Delivery and Participant Responsiveness tend to suffer dramatic setbacks.

3) Failure to Thrive

The third trajectory, Failure to Thrive, represents a pattern wherein *lack of researcher feedback (i.e., how the program implementation is working) causes instructors to gradually shift away from program goals, theories, and procedures present at the time of initialization.* In part, this appears to involve situations where participating educators "do it for the researcher(s)" or for the status of being part of the research team, or the resources involved in a grant project. Once the project originators leave, the teachers simply move on or revert to prior instructional practices. However, prior research indicates that the problem may be much more complicated than this.

In describing a situated view of naval quartermasters, Hutchins (1995) addressed how success arises from interaction both among and between people and artifacts in the world. From this perspective, failure can occur when any one of these potential interactions is interrupted: teacher-tool, researcher/designer-tool, and teacher-researcher. Each interaction must be functioning and ongoing to provide the feedback necessary for sustaining technology-rich programs over time. While teachers often crave interactions with talented adults and welcome the opportunity to share their insights, debate with researchers, reflect on and explain their own pedagogy, and receive critiques of their teaching from academic peers, the social and cognitive factors arising from broken interaction can obscure progress toward a common objective. Barron (2003) explained this as smart groups capable of generating workable solutions ignoring those solutions as a result of structural social dynamics. Following this line of logic, any interruption of teacher-researcher interaction, intended or not, may allow misunderstanding, lack of investment, social conflict, or other social dynamics to overshadow the project's original goals. These issues eventually consume program implementation and push participating teachers back into their respective comfort zones.

Avoiding the Precipice of Epic Fail

With the advent of the No Child Left Behind Act, sweeping instructional change has become even more difficult to achieve than when many new, innovative instructional projects began during the 1980s and 90s. School devotion to improving test scores has come largely at the expense of innovation, and direct instruction in the form of test preparation has served almost exclusively as the means to contend with the ever-growing gauntlet of standardized testing. This requires designers to devise game-based learning frameworks that meet parent, teacher, district, and researcher needs while simultaneously avoiding the constraints that suffocated Logo, Jasper, HyperCard, and, more recently, *Operation BIOME*.

Because no two school environments are identical, some customization should be expected at every implementation site. However, the authors believe this customization can be accomplished in a way that maintains program fidelity and allows project originators to avoid the three predominant trajectories of failure described herein. Avoiding the precipice of epic fail requires the clear articulation of which program elements – including content and method of implementation – can be entirely altered, changed within a set margin, or not changed at all. This means anticipating which program elements might challenge traditional school instruction and planning ahead to avoid any disruption of the innovation's theoretical integrity. At times, we have referred to this as the "fixin's bar" approach where designers select an array of possible additions or enhancements that could be applied to locally customize the program without ruining the "flavor" of the meat of the innovation.

Fatal Mutation Due to Assimilation can be addressed with planned customization and clear designation of critical components. Project originators should anticipate that each new site will seek to customize the intervention to meet the unique characteristics of the specific context. For game-based learning designers and researchers, specifically, this may mean tailoring the game to fit a pre-existing curriculum rather than attempting to replace all materials that already exist. A 1:1 learning and game objective relationship can ensure overlap between state and national standards (e.g., Young et al., 2012) and decrease the likelihood that participating teachers will simply assimilate the game into direct instruction or other pre-planned activities.

As indicated by *Operation BIOME*, Loss of Fidelity can become a considerable problem when project originators attempt to control and quantitatively evaluate program implementation in a living school environment. Variables tracked through teacher-guided discussion, answers to follow-up questions, and how well each teacher connects new content to prior content can improve the likelihood of measuring the extent to which fidelity has suffered. Similarly, regular follow-up, including audio/video, on-going training, face-to-face focus groups, surveying, student feedback, and other qualitative tools provide a glimpse at teacher understanding and whether or not participants understand how to successfully implement the program *in situ*. All new innovations should be designed with a companion text that explicitly reveals the presumed theoretical framework, going so far as to frame the basis, history, and practical implications of the underlying theory.

Failure to Thrive could be combated through the creation of a self-sustaining, dynamic community of practice (e.g., Lave & Wenger, 1991) that exists alongside the original innovation much like the websites and other metagame materials designed to support many massively multiplayer online games. Any such community must be able to change as needed within the parameters laid out by the project originators and the underlying theory. While this might include the creation of a webpage, forum, YouTube videos, wiki, and/or series of regular meetings, continued success will only come from ongoing facilitation by leading experts (i.e., project originators and trained practitioner-specialists). All teachers hoping to become community practitioner-specialists should be capable of describing the program's underlying theory and show evidence of their ability to adapt the theory to fit within the scope of a living classroom environment. When possible, original practitioners and other expert researchers should return to the community for two-way dialogue concerning information regarding progress in the field, modifications to the theory, and related research projects. Additionally, the application of cost-sharing user fees may increase school buy-in, providing impetus to remain involved with the innovation and assist with the burden of community development. Though teacher-tool and researcher/designer-tool interactions will likely continue regardless of community formation, teacher-researcher communication is the only element that will sustain program fidelity beyond the original scope of the project.

Any game-based learning research model aimed at long-term viability will require researchers capable of on-going school-level involvement, random fidelity checks, and two-way monitoring of the innovation. Project originators should be mindful of ways in which they can maintain an active community role and use on-going educational changes at federal, state, and local levels for guidance on shifting K12 pedagogy toward more meaningfully authentic student learning experiences. While the authors' goals may be lofty, past precedent indicates that even slight breakdowns in program framing and teacher-researcher dialogue can be incredibly detrimental to project longevity. The history of other large-scale attempts to introduce new approaches to instruction have given the game-based learning field a rare opportunity to turn repeated failure into a powerful alternative to the current state of K12 education. In the wise words of *Diablo*'s Cain, let us "stay a while and listen" that we might find the path to educational reformation scattered among the ashes of our predecessors' epic fails.

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Papers

Leveling-Up: Evolving Game-Inspired University Course Design

Stephen Aguilar, Barry Fishman, Caitlin Holman, University of Michigan
aguilars@umich.edu, fishman@umich.edu, cholma@umich.edu

Abstract: The authors examine two iterations of a high-enrollment university political science course designed around motivational constructs found in video games. The idea of "leveling-up" is used as a driving metaphor to showcase the fact that both the course and the research design are an iterative process driven by improving and understanding student outcomes. Both the courses and the research design employed to understand them have evolved over two academic years. We demonstrate that positive effects on students' motivation to engage with coursework (and sense of control) remain robust across both iterations. We also employ social network analysis to understand how student networks form around how students learned to make sense of the grading system from each other.

Introduction

There has been a flurry of recent innovation driven by the desire to re-contextualize and operationalize various constructs inherent in (good) video game design to improve educational outcomes (e.g., Sheldon, 2012). Indeed, many of the features of well-designed video games that Gee has outlined—identity play and the formation of affinity groups, exploration in and of semiotic domains, support for risk-taking, amplification of input, support for practice and ongoing learning, on-demand and just-in-time information, multiple routes towards success (Gee, 2003)—are also features of well-designed learning environments. "Gamification," or game-inspired design, seeks to more directly leverage the mechanisms that make video games so motivating.

As education researchers and interventionists we are invested in this design process and are curious about whether or not game-inspired assessment systems change students' relationship to the class and promote a state of flow (Csikszentmihalyi, 2008). We wonder if game-inspired grading systems lead students to work harder and/or feel in more control over their grades. We also wonder if all students work harder, or just certain types of students (e.g., students such as those who tend to learn for learning's sake regardless of context).

To begin to answer these questions we examine a political science course taught at the University of Michigan. The professor of this course has experimented with implementing gameful elements to his course over the years, and has consequently modified his course over time. As researchers we have been involved in two iterations—or "levels"—of his course, and our research design has "leveled-up" as well. This paper outlines the development of this course as well as the research agenda deployed to understand it.

Specifically, we ask the following research questions:

(1) What is the relationship between students' motivation profiles and whether or not the grading system *encourages them to work harder*?

(2) What is the relationship between students' motivation profiles and whether or not they feel *more in control of their grades*?

(3) What is the relationship between students' motivation profiles and whether or not they *complete more assignments*?

(4) What is the relationship between students' motivation profiles and their perceived difficulty of *earning the grade they want*?

(5) What is the relationship between students' attitudes and engagement with the grading system and the rate at which they self-report selecting novel assignment types?

Questions one through four are addressed in both iterations of the course and will serve to show that results are replicable. Question five explores academic risk taking: an affordance of game-inspired course design and a desired outcome of university level courses in general. We also employ social-network analysis approaches to explore a sixth question:How do students make sense of a complex game-inspired grading system within and across their social networks?By employing social network analytic techniques, we give the "game" of the course a visual structure by identifying how players form informal knowledge partnerships, which allowed us to see how the game played out.

Gaming Political Science

The professor of the political science course under examination wished to design a course that gave his students more autonomy over the ways they approached course content. To accomplish this, he presented students with four options (i.e., “pathways”) that could be tailored to their own individual preferences. While both iterations of the course operate similarly, we describe each version to highlight differences and ground further discussion.

Fall 2011: Expanding Student Choice to Increase Motivation (Level-1)

The grading system of the political science course gives students control over their final grade in two distinct ways. First, students must choose the *types* of assignments that make up 60% of their final grade. In so doing they complete two out of three types of assignments offered throughout the term: traditional essays, an open-ended group project, and posting and responding on the class blog. Second, students are given the freedom to determine how each of the individual assignments is *weighted* for the final course grade calculation. In order to “unlock” their ability to choose and weight their coursework, however, students are required to complete a quiz that assesses their understanding of the course’s grading system. Once this has occurred students can choose the path they will follow to complete the course. The remaining 40% of a student’s grade is traditional in that it consists of a core set of requirements: attendance (5%), “keeping up with the reading” (15%, assessed via quizzes and/or blogs), and “section,” which consists of attending discussion sections (20%). Figure 1 is an example of the grading system in action; Student “A” chose to give three of the four assignment types equal weight, while Student “B” chose to weigh the first essay more heavily (presumably because he perceives himself to be a good writer).

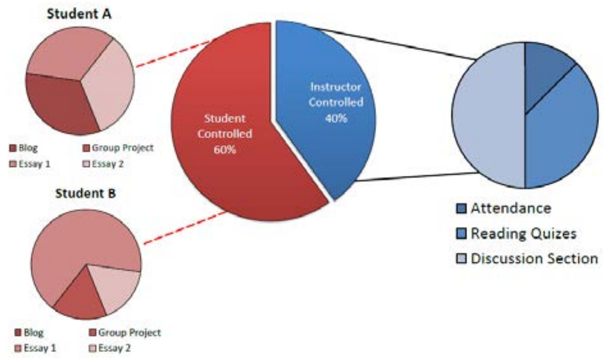

Figure 1: Fall 2011 possible course assignment configurations.

Fall 2012: Operationalizing Student Choices via Badges and LMS (Level-2)

In order to facilitate the added complexity, the professor of the political science course, in partnership with the authors, implemented *GradeCraft—a* Learning Management System (LMS) used to keep track of the various moving parts of the grading system. GradeCraft consisted of a grade book as well as features that allowed students to track and predict their desired grade. It also allowed for the inclusion of badges that were awarded to students for various accomplishments. (GradeCraft follows gameful design principles, but is not described in this paper for reasons of space.)

As with level-1, the level-2 version of the political science course assigned forty percent of students’ grade in the traditional manner. Students were again able to choose what types of assignments would make up the remaining sixty percent of their grade. The four assignment types, however, were slightly modified consisted of traditional essays, an open-ended group project, a “new media” individual project, and contributing to the class blog. Students were encouraged to work on two of the four assignment types, but are allowed to select any number. Students were again given the freedom to determine how each of the four assignment types was weighted. This decision was operationalized by giving students six points (called “Kapital”) to “spend” on any assignment type they wished. They spent their points through the LMS, and these points determined the weight of each assignment. A student could have, for example, assigned all six points to academic essays (Student “A” in Figure 2). Doing so would make essays six times as important as before. Any assignment type without at least one Kapital point lost half its value when calculating final course grades.

In order to recognize and/or incentivize certain behaviors, students were awarded badges. Cumulatively, these badges were valued at up to twenty-five percent of the total points possible, and thus served as de facto extra credit. Figure 2 shows two students with different "game plans" for succeeding in the course, and Table 1 summarizes key differences between the two iterations of the course:

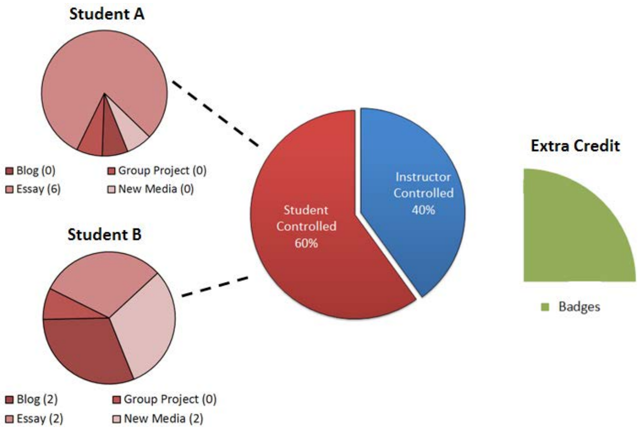

Figure 2: Badges serving as an additional gameful layer.

Level	Term Taught	Grading System Platform	Game-inspired Elements
1	Fall 2011	None (students manage themselves)	Assignment Choice, Assignment Weighting
2	Fall 2012	*LMS Supported*	Assignment Choice, Assignment Weighting, *Badges, Grade Predictor*

Table 1: Comparing levels 1 and 2.

Methodology

Data from both courses was gathered using online surveys administered in the final weeks of the term. The survey contained motivation and attitude items measured on a 5-point Likert scale. Academic Novelty and social network questions were only present in the Fall 2012 version of the survey. The entire survey took about 15 minutes to complete in each year.

Sample

For the Fall 2011 term there were 292 students enrolled, and 176 completed the survey, for a response rate of 60%; for the Fall 2012 term there were 299 students enrolled, and 232 completed the survey, for a response rate of 78%.

Measures

To measure student motivation we used the Patterns of Adaptive Learning Scales (PALS; Midgley et al., 2000). This instrument has been validated and used in multiple areas (Ames, 1992; Blumenfeld, 1992; Elliot & Harackiewicz, 1996), and produces scales that indicate a respondent's mastery goal orientation (MGO), performance-approach orientation (PA), performance-avoidance orientation (PV), and avoiding novelty (AN). An example item relating to MGO is: "One of my goals in this class is to learn as much as I can." An example item relating to PA is: "I want to do better than other students in my class." An example item relating to PV is: "It's very important that I don't look stupid in this class." An example item relating to AN is: "I prefer work as I have always done it, rather than trying something new." Each of the scales used in the survey was highly reliable (1).

Results

OLS regressions were used to test research questions one through five (Table 2). Results are promising and indicate that whether students "like" the grading system is positively related to whether they feel encouraged to work harder; their perceptions of their control over their final grade; whether students complete more assignments; and the ease with which students feel they can earn the grade they want. We note that these findings replicate observations from our previous work on this topic (Fishman & Aguilar, 2012).

	Fall 2011 (Level-1)			Fall 2012 (Level-2)		
	β	SE β	R^2	β	SE β	R^2
Encouragement of More Hard Work (2)			.591			.613
Intercept	.780	.344		1.10	.341	
Mastery Orientation	.182†	.093		.198**	.079	
Performance-Approach Orientation	.189	.132		.132	.093	
Performance-Avoid Orientation	-.091	.130		-.012	.092	
Interest in Class (3)	.101	.095		.054	.084	
"Liking" of Grading System (4)	.462***	.073		.494***	.054	
Control Over Final Grade (5)			.674			.668
Intercept	1.052	.324		1.749	.319	
Mastery Orientation	-.097	.087		-.014	.074	
Performance-Approach Orientation	.162	.124		-.122	.087	
Performance-Avoid Orientation	-.098	.122		.164*	.086	
Interest in Class[b]	.103	.090		-.054	.079	
"Liking" of Grading System[c]	.637***	.069		.637***	.050	
More Assignment Completion (6)			.495			.515
Intercept	.973	.385		.810	.379	
Mastery Orientation	.261***	.104		.129	.087	
Performance-Approach Orientation	.207	.147		.083	.103	
Performance-Avoid Orientation	-.052	.146		-.028	.102	
Interest in Class	.155	.107		.242**	.094	
"Liking" of Grading System	.276***	.082		.341***	.059	
Ease of Desired Grade Attainment (7)			.766			.547
Intercept	.763	.270		1.671		
Mastery Orientation	-.091	.072		-.023		
Performance-Approach Orientation	.174†	.103		-.056		
Performance-Avoid Orientation	-.056	.102		.085		
Interest in Class	.039	.075		-.090		
"Liking" of Grading System	.718***	.058		.561***		
Assignment Variation (8)						.546
Intercept				1.687	.383	
Mastery Orientation				-.020	.089	
Performance-Approach Orientation				-.052	.104	
Performance-Avoid Orientation				.083	.105	
Avoiding Novelty				-.001	.076	
Interest in Class				-.091	.094	
"Liking" of Grading System				.559***	.060	

*Note: *** = p< .001; **= p < .01; * = p <.05; †= p < .10*

Table 2: Replication across two iterations of the course.

We were also pleased to find preliminary support for the idea that if students like the grading system, that they will be more likely to try assignments that they may have otherwise avoided *regardless of incoming predisposition towards avoiding academic novelty*.

Grading System Help Network: Social Network Analysis

If the grading system, and whether or not students "like" it, is the mechanism that is at play with game-inspired courses, as our data suggests, then it is important to explore how information regarding the grading system is disseminated among students. To explore this question, we asked students to name other students they spoke with about the grading system, and using social network analysis tools (Csardi & Nepusz, 2006) created the representation shown in Figure 3.

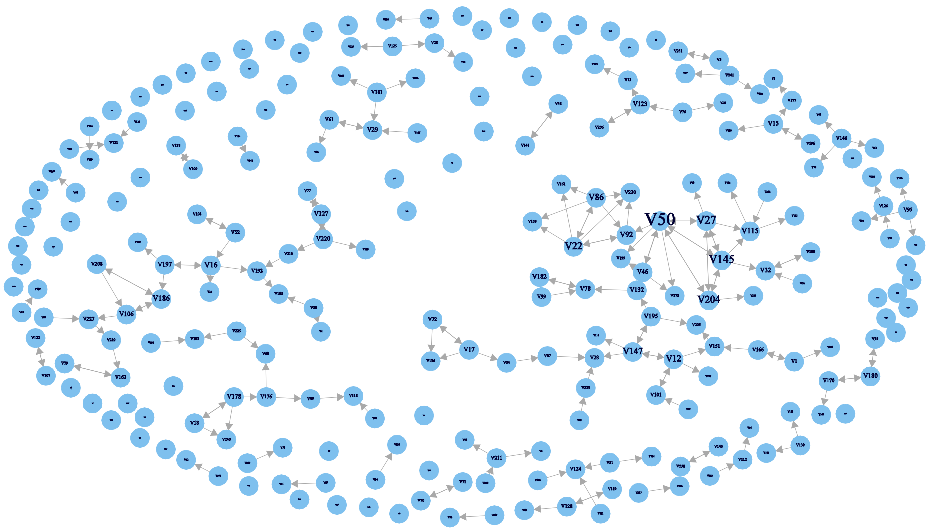

Figure 3: Fall 2012 Political Science grading system help network.

Initial social network analysis yielded a pattern of interaction that seemed dominated by solo students, and also contained a number of dyads and triads (Figure 3). One possibility for this pattern is that most of the students in the course were able to understand the grading system on their own, or were able to find one or two peers to help them make sense of it.

Upon closer inspection we also noticed evidence of two "sub-networks." Network A and Network B (Figure 4) are each characterized by different suggested behaviors across the actors of each network. Network A suggests a "daisy-chain" pattern of interaction that is not necessarily dominated by a central figure, but instead represents knowledge of the grading system moving from one person to one or two others, without establishing a hub of information. Network B, on the other hand suggests the opposite. Student V50 serves as a prominent node (due to being named multiple times compared to his or her peers) and is generally surrounded by other prominent nodes such as students V20, V145, and V27. Both sub-networks imply different ways that information about the grading system was disseminated.

Network A **Network B**

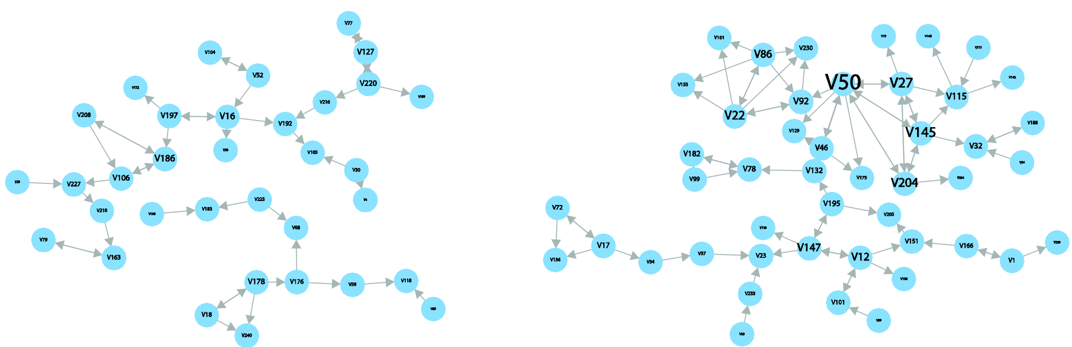

Figure 4: Fall 2012 grading system help sub-networks.

Which factors relate to how these sub-networks form? Logistic regression analysis suggests one possibility: Students were asked to identify the sources of information they used to make sense of the syllabus—which represented the only formal documentation of the grading system. Consequently, we infer that asking for help in understanding the syllabus serves as a reasonable proxy for asking for help with the grading system.

Results indicate that, after controlling for other possible sources of information (e.g., the syllabus itself or the professor), the Performance-Approach Orientation (PA) was the only factor that significantly predicted *students asking other students* for help with the grading system (Table 3). Since PA orientation revolves around public demonstration of competence this makes sense—asking for (and giving) help likely represents a desire to be publically competent when engaging with the grading system, which requires understanding it first. We reiterate, however, that these findings are preliminary and warrant further investigation.

	β	*SE β*	e^{β} *(odds ratio)*
Intercept	-.471	.347	.624
Controlling for other Sources of Information			
Syllabus	.144	.295	1.155
Professor	.018	.303	1.019
Graduate Student Instructor	.455	.356	1.576
Motivation Factors			
Mastery Orientation	.120	.149	1.127
Performance-Approach Orientation	.467*	.216	1.596
Performance-Avoid Orientation	-.349	.218	.705
Avoiding Novelty	-.088	.153	.915

*Note: **= p < .01; * = p <.05; †= p < .10*

Table 3: Students helping fellow students in understanding syllabus.

Implications

We are pleased that the second iteration of the political science grading system replicated results from the prior year (Fishman & Aguilar, 2012). This suggests that game-inspired grading system interventions can be robust over time. If true, then interventions such as this one can scale so that more students can feel a sense of control over their final course grade, as well as be motivated to work more and work *harder.* (For what's a good game if not one that makes you want to work hard to "beat it"?) Yet, games aren't simply about putting in time. They are also about having the freedom from failure to develop skills that might otherwise go underdeveloped. This is why we are happy to have collected evidence that suggests game-inspired grading systems support tolerance for academic novelty, regardless of the motivation profile a student enters the course with.

Further Study

Future research will ideally continue to add evidence to the notion that game-inspired grading systems are learning environments worth spreading because they encourage autonomy, lessen the risk of failure, and motivate students to work harder. Yet, we also recognize that these grading systems are just that, *systems* that unfold dynamically. In order to better understand them and what parts of them promote adaptive learning behavior we have taken an initial step towards exploring the underlying networks at play thanks to social network analysis techniques. While our data is preliminary, we hope make more sense of it over time. This is why we strive to push our methods as well as our design, so that our research may continue to level-up.

Endnotes

(1) Fall 2011 MGO α=.92, Fall 2012 MGO α=.87; Fall 2011 PA α=.88 Fall 2012 PA α=.89; Fall 2011 PV α=.80, Fall 2012 PV α=.81; Fall 2012 AN α=.73; Fall 2012 AN: α=.73.

(2) "The grading system encourages me to work harder than I would in a different kind of grading system"

(3) "I find this class interesting"

(4) "I like the grading system"

(5) “I have more control over my final course grade because of the grading system”

(6) “I do more assignments because of the grading system.”

(7) “I think it is much easier to earn the grade I want because of the grading system.”

(8) “The grading system encourages me to work on assignment types I would normally avoid.”

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Supporting Social-Emotional Development in Collaborative Inquiry Games for K-3 Science Learning

Vincent Aleven, Steven Dow, Michael Christel, Scott Stevens, Carolyn Rosé, Kenneth Koedinger, Brad Myers, Julia Brynn Flynn, Zane Hintzman, Erik Harpstead, Soyeon Hwang, Derek Lomas, Chris Reid, Nesra Yannier, Mitra Fathollahpour, Amos Glenn, Jonathan Sewall, John Balash, Nora Bastida, Chandana Bhargava, Sean Brice, Matt Champer, Samantha Collier, Jingyi Feng, Danny Hausmann, Meng Hui Koh, Weiwei Huo, Qianru Ma, Bryan Maher, Weichuan Tian, Xun Zhang

Human-Computer Interaction Institute / Entertainment Technology Center Carnegie Mellon University

Abstract: While games for science learning show considerable promise, they tend not to focus on the youngest students. We are engaged in a project to create and evaluate a series of games for science learning for students in Kindergarten through grade 3. These games address a range of educational goals: to help students understand targeted science principles, develop scientific inquiry skill, and deal with situations that call for social-emotional skill. In two of our games, *Beanstalk* and *Teeter Totter Go,* players alternate between problem-solving activities and inquiry activities integrated in a single narrative context. The main contribution of the work is a design for science games for young children that synergistically addresses scientific inquiry, social-emotional development, and science content learning. The games serve as platforms for research into how best to support this synergy.

Introduction

Although recent reviews concluded that there is little scientific evidence that educational games can effectively support science learning (Honey & Hilton, 2011; Tobias & Fletcher, 2011; Young et al., 2012), the landscape is beginning to change. There are by now quite a few games for science learning and evidence is beginning to emerge that they can be effective (Barab et al., 2009; Ketelhut, Nelson, Clarke, & Dede, 2010; Meluso, Zheng, Spires, & Lester, 2012). However, relatively few science games exist for young children at the beginning of their school careers (e.g., Kindergarten through grade 3). Designing effective games for this age group is a significant challenge, even beyond the usual challenges involved in designing educational games.

While scientific inquiry is widely viewed as an important educational objective (Honey & Hilton, 2011), it is a great challenge for a young demographic to learn these skills. It is appropriate to focus on supporting inquiry skills as a *collaborative* activity for a number of reasons. First, "real" scientific inquiry is almost invariably a collaborative process. Further, collaborative learning, appropriately scaffolded, has a strong track record in improving learning (Kollar, Fischer, & Hesse, 2006). Finally, learning to collaborate well is an important goal in its own right. However, collaborating is not easy for children in this age group as they may not have fundamental collaboration skills or the necessary social and emotional maturity. Therefore, to support collaboration and children's ability to collaborate, our work focuses on measuring and scaffolding students' social and emotional learning (SEL). Differences in socio-emotional skills—such as individual persistence and healthy interdependence—can be predictive of later academic success (Cunha & Heckman, 2006). An additional goal in our games is for students to come to a better understanding of the physical phenomena that they are investigating through collaborative inquiry. We focus on physical systems and principles that are rich enough to provide a real challenge and sense of discovery, but are not so complicated (in terms of physics and mathematics) as to be beyond the age group's ability to comprehend.

Underlying our games is a fundamental design hypothesis yet to be confirmed, namely, that these combined objectives are achieved when inquiry activities are interleaved with problem-solving activities within a single narrative context, and opportunities for SEL (such as seeking help and acknowledging and resolving different viewpoints) are embedded in a way that is relevant to the on-going inquiry and problem-solving activities. This narrative context provides motivation, meaning, and a degree of cognitive structure (e.g., Dickey, 2006). We see many open questions related to how best to achieve this combination. We view our games as platforms to investigate these questions. At this stage, the games offer initial approaches, not final answers.

In this paper, we present two of our games, *Beanstalk* and *Teeter Totter Go (*http://www.etc.cmu.edu/engage/*).* We discuss the three educational objectives addressed in these games and illustrate how these games address those objectives.

Educational objectives

As part of our approach to creating effective educational games (Aleven, Myers, Easterday, & Ogan, 2010), we spent a significant amount of time identifying the objectives that the games address.

Scientific Inquiry learning objectives

Scientific inquiry requires a broad range of skills and methods, but what subset of these skills is within reach of children in grades K-3? Guided by the National Research Council Framework (National Research Council, 2012), we decided to focus on making predictions as well as arguing from evidence. Specifically, the games aim to help students learn to:

1. make predictions about how the given physical system will behave in a specific case;
2. observe whether predictions are met;
3. explain observations by identifying features of the physical system that caused the outcome;
4. pose hypotheses as to how features connect to outcomes, recognizing that there are sometimes competing hypotheses;
5. recognize whether an observation is consistent with, inconsistent with, or not relevant to a given hypotheses; and
6. revise a hypothesis as necessary in light of observations.

These objectives are consistent with the NRC standards: #3) Planning and carrying out investigations, #4) Analyzing and interpreting data and #6) Constructing explanations and designing solutions consistent with available evidence.

Science content learning objectives

In addition to objectives for learning inquiry, *Beanstalk* and *Teeter Totter Go* are designed to support science content learning. The goal is for students to understand the principles governing the balance scale and the sum of cross products rule (weight x distance from fulcrum) that can be used to determine when a scale will balance. For instance, if the blue supports are removed from under the balance scales in Figure 1, in both instances the left side will go down. Prior research and our own preliminary data indicate that understanding the balance scale poses a substantial challenge for children in the targeted age group. Our games are designed to help children progress through a series of four increasingly sophisticated mental models first described by Siegler (1976):

Figure 1: Balance scale problems

1. Children only pay attention to weight, not to how far away from the fulcrum the weights are; children with this mental model make incorrect predictions for both cases in Figure 1.
2. Children also consider distance, but only when the weight is equal on both sides; otherwise, they go by weight. Children with this mental model correctly predict the case on the left in Figure 1 but not the one on the right.
3. Children consider both weight and distance, but when these two cues suggest different outcomes (i.e., one side has more weight, but the weight on the other side is further away from the fulcrum), they do not know how to resolve the conflict and guess. Children with this mental model recognize that the scale shown on the right in Figure 1 is problematic but do not know how to deal with it.
4. Children use the sum of cross products rule. Only children with this level 4 model are able to solve all balance scale problems correctly.

Social-Emotional Learning Objectives

A key challenge for 21st-century schools is serving culturally diverse students with different abilities and motivations for learning. Programs geared toward social and emotional learning have been shown to increase academic performance, to improve attitudes about self and others, and to promote positive social behaviors within schools (Durlak, Weissberg, Dymnicki, Taylor, & Schellinger, 2011; Payton et al., 2008; Zins, Weissberg, Wang, & Walberg, 2004). For our age group, state standards for social and emotional/personal development typically focus on self-concept, self-regulation, and the development of social interactions. Kindergarten educators focus on pro-social relationships with peers and adults. By second grade, there is an additional focus on caring for others and on self-reliance. Throughout this period, socio-emotional learning principles concentrate on a healthy balance between independence and interdependence, between pride in one's own work and recognition of the value of others' work, between becoming self-reliant and learning to ask for help.

To support this social development goal of positive interdependence, the games are designed to create scenarios around three SEL goals, namely, that children learn to:

1. ask for help when encountering a problem,
2. cooperate with a peer to reach a shared goal, and
3. solve disagreements through interactions and discussions with peers.

The Games: *Beanstalk* and *Teeter Totter Go*

A key challenge in the design of our games is to tie together the three categories of educational objectives in a coherent and game-like manner. As mentioned, each of *Beanstalk* and *Teeter Totter Go* uses a single narrative context to guide players in problem-solving tasks and inquiry tasks, each related to the same physical system (i.e., the balance scale). The knowledge gained through these two types of activities may be mutually reinforcing. Problem-solving activities pose engaging challenges and may enhance a student's intuitive understanding of physics. On the other hand, inquiry activities may help students develop scientific reasoning skills and help them develop a more verbal understanding of the given physical system– for example, explanations and hypotheses as to when the scale balances or tips.

Figure 2: *Beanstalk* problem-solving level (left) and inquiry level (right)

Beanstalk is based on the folktale of *Jack and the Beanstalk,* in which Jack climbs a beanstalk that grows into a land where an evil giants lives. In the *Beanstalk* game*,* the evil giant is replaced by a friendly monster living on the moon. While asleep, the monster unknowingly pushes his teddy bear out of bed causing it to fall all the way down to earth, landing right where Jack and Jackie live. The player must return the monster's teddy bear. Luckily, a large beanstalk has sprouted, offering a way to where the monster lives, but it will not grow if the beam at the top does not stay balanced. Unfortunately, the beam attracts bugs, causing it to tilt (Figure 2, left). Thus Jack or Jackie must continuously balance the beam by growing flowers to counterbalance the bugs (see Figure 2, left). Balancing the beam in increasingly more challenging configurations is the main problem-solving activity. These activities are interleaved with inquiry activities. Occasionally, a flock of seagulls lands on the beam, blocking progress. They will not "skedaddle" until the player carries out an inquiry as to whether the beam will balance and why (see Figure 2, right). With the seagulls departed, the beanstalk continues to grow as long as the player keeps the beam balanced. Eventually, the player returns the teddy bear for a happy reunion with the friendly monster.

In *Teeter Totter Go* problem solving and inquiry activities are embedded in an overall narrative. *Teeter Totter Go* is an adventure set in an outback wilderness area. The player, a young ranger (see Figure 3), must deliver badges for a new cohort of young rangers to a remote ranger station. Unfortunately, a villain runs off with the badges and, while fleeing, looses the badges scattering them across the wilderness. The player must follow the villain's path to collect the scattered badges. Along the way, she must cross ravines by walking over a log that teeter-totters on a big rock. To walk over the log, it must first be moved into the right position, either horizontal or tipped to the left or right (Figure 3, left). The player moves rocks on or off the log while collaborating with Billy, a non-player character (NPC) sporting a purple jersey. The player then walks across the log, collecting badges as she goes.

Figure 3: *Teeter Totter Go* problem-solving level (left) and inquiry level (right)

Problem-solving activities in which the goal is to balance or tip the log are interleaved with inquiry activities in which the player poses hypotheses about balancing. The inquiry activities commence immediately following a cut scene in which the villain expresses confidence that the player will *never* be able to figure out how to find all the badges. The player can prove the villain wrong by figuring out, through inquiry, a general principle for making the log balance or tip (figure 3, right). The villain gloats if the player's explanation was incorrect or expresses dismay that the player was able to "figure it out." Eventually, the player delivers the badges to the ranger station.

Problem-Solving Levels and How SEL is Supported

In both games, the problem-solving levels are sequenced from easy to hard based on the Siegler models described above. Although the two games have different level sequences, in both games, the early levels target situations in which both the weight and the distance (i.e., how far away the weight is from the fulcrum) is kept the same on both sides of the beam or log (Siegler level 1). On these levels, a simple "mirroring" strategy suffices to balance the beam or log. On subsequent levels, the mirroring strategy does not work, either because there is not enough weight to put on the beam or log, or because positions needed for mirroring are blocked. (Positions on the beam or log may be blocked from receiving weights in order to prevent solutions that are either simpler or harder than intended.) These levels are more challenging as players learn to trade off weigh versus distance, applying simple versions of the cross product rule (Siegler level 4). Several additional factors are varied to affect the difficulty of levels, such as the number of "weights" available, the number of positions in which there are weights, and the positions on the beam that are open or blocked

As mentioned, a key aim in designing the games was to support players' social and emotional development, with a focus on help seeking, collaboration, and resolving disagreement through discussion. As we sought to support these goals in *Beanstalk* and *Teeter Totter Go,* several design issues came under consideration. It was important to emulate social interactions, but we could not allow children to chat or speak directly with each other, as a privacy and security concern for parents, given that the games were designed for use on the Internet, not just in schools. As a result, our games rely on interactions through game objects and menu options. Likewise, due to the technical challenge of connecting two or more players for the same game session, we decided to focus our first iteration on individual gameplay situations in which the player collaborates with one or more NPCs.

We first consider interactions with NPCs that occur on the problem-solving levels. In the *Beanstalk* game, the player interacts with two characters, Chicken and Crow, with different personalities and capabilities to support socio-emotional learning. To support our first SEL goal, help seeking, at any time, the player can click on the buttons for Chicken or Crow to ask for help (Figure 4, left, bottom). Both characters are forthcoming with useful advice as to how to balance the beam but also mix in other commentary. At the higher tiers, *Beanstalk* also supports collaboration, our second SEL goal. The player can leverage Chicken and Crow's special abilities. When the player runs out of water and therefore cannot grow any more flowers to balance the beam, he or she can ask Chicken to lay eggs and thus add weight to the beam (Figure 4, left, top-right). Likewise, at the player's request, Crow will eat bugs, which cannot be removed otherwise, to reduce the weight on the other side of the beam.

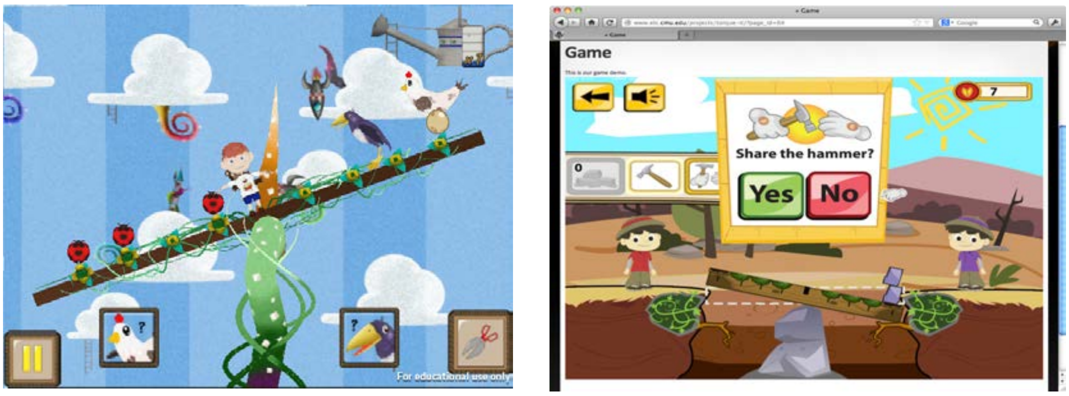

Figure 4: SEL support during problem solving in *Beanstalk* (left) and *Teeter Totter Go* (right)

In *Teeter Totter Go*, as in *Beanstalk,* the SEL support on the problem-solving levels focuses on help seeking and collaboration. The player collaborates with an NPC (Billy) at the opposite side of the ravine. They take turns adding or removing rocks, working on their own end. When the log reaches the correct position and the player walks across to join the peer, both characters smile. Thus, a key incentive for defeating levels is a social one. Moreover, some levels require sharing of resources: the player or Billy must use a hammer to clear bricks from the log. However, there is only one hammer for both players. The player must either pass the hammer to Billy or ask for the hammer from Billy (see Figure 4, right). The player can choose not to share the hammer, but it would make the level difficult — and, in some cases, impossible—to solve. In the future, if a player consistently exhibits anti-social behavior (e.g., not sharing the hammer with the peer), the game can scaffold the player towards more social game behaviors. The SEL goal of "asking for help" is further supported by giving the player an option to ask the scout leader to explain the game goals and mechanics.

Inquiry Levels and How SEL is Supported

Beanstalk and *Teeter Totter Go* engage students in inquiry practices such as allowing the player to make predictions based on their current knowledge, construct new hypotheses by comparing explanations of observations, and argue for (or abandon) the hypothesis using recorded or new observations. In each game, inquiry occurs at the end of each tier, and serves in part to reinforce what was learned in the preceding problem-solving levels and in part to introduce new ideas.

In *Beanstalk,* inquiry activities commence when sea gulls land on the beam; they will not leave until the situation has been clarified through inquiry. The game guides players through a predict-observe-explain cycle, a standard pattern in science education for the given age group. First, the player and the NPCs (Chicken and Crow) all make a prediction (Figure 2, right) as to what will happen when Chicken and Crow stop holding the beam steady. Invariably, the predictions conflict. When Chicken and Crow fly away, the player and characters observe whether the beam tips or balances, as way of testing their prediction. The player then is asked to provide an explanation by selecting a general rule that captures the observed behavior (Figure 5, left; the game speaks the words aloud since the target population often cannot read). The game then gives generic positive feedback. Throughout the inquiry activity, the NPCs model use of scientific terminology like "hypothesis," "investigation," "explanation," and "prediction." The current version of the game supports our third SEL goal (resolving disagreement constructively) in a limited manner, by modeling how, during collaborative inquiry, disagreement can occur (the characters invariably make different predictions) and how this specific type of disagreement can be resolved by careful observation. We plan for later versions of the game to support more elaborate discussion regarding competing predictions and hypotheses.

The inquiry activities in *Teeter Totter Go* follow a similar pattern as those in *Beanstalk*, but are extended to include a log book in which hypotheses and observations are recorded. Using the log book, the player considers a hypothesis in light of multiple observations. With respect to supporting SEL, the inquiry activities in *Teeter Totter Go* provide opportunities for discussion between the player and the virtual collaborator, Billy, in support of the SEL goal of "solving disagreements through interactions and discussions with peers" (see Figure 5, right). In the predict step of the predict-observe-explain inquiry process, the characters predict the outcome independently and therefore will sometimes make different predictions. When and if they do disagree, the game gives the player a choice of behaviors that represent varying degrees of social adeptness. The player can choose to "discuss/explain" his/

her answer (a pro-social behavior), tell Billy he is wrong (an anti-social behavior), change his/her answer (a mildly social behavior), or skip the discussion and go immediately to see the outcome (a non-social behavior). If a player behaves socially, he/she is rewarded with further social interactions with the peer. In this way, the game reinforces the goal of helping the child think about and explain the science phenomena. We plan to extend the game so that if a player consistently behaves anti-socially, the game will scaffold the player towards more social interactions.

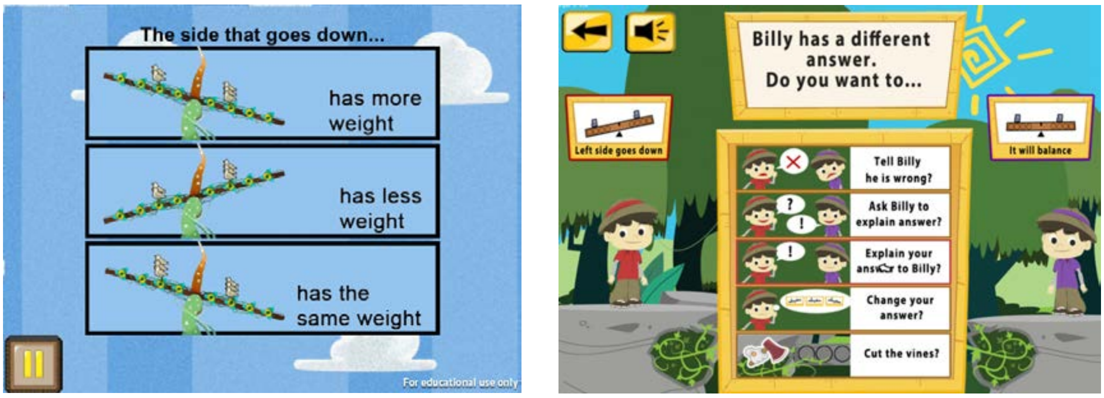

Figure 5: Inquiry in *Beanstalk* (left) and with SEL support in *Teeter Totter Go* (right)

Discussion and Conclusion

We have illustrated our approach to designing collaborative inquiry games for young children. Both *Beanstalk* and *Teeter Totter Go* have seen multiple cycles of playtesting and redesign and have been improved during these iterations. In addition, *Beanstalk* has been through an extensive redesign in order to better accomplish the inquiry and SEL goals. Feedback from children has been largely positive. *Beanstalk* has also been used in three classroom pilot studies, with over 200 students. We are analyzing the data about the success of *Beanstalk* in teaching the SEL and physics principles.

A major challenge in creating collaborative inquiry games like *Beanstalk* and *Teeter Totter Go* is how to best integrate compelling narrative and game play with effective support for scientific inquiry, social-emotional learning, and science content learning. In particular, it is challenging to combine problem solving and inquiry in a way that both are perceived as fun – rather than the inquiry activities being seen as an unwelcome interruption of the flow of the game. Feedback from the latest playtesting session with *Teeter Totter Go* suggests we have made progress toward that goal. In initial versions of the game, the students really liked the problem-solving levels but disliked the inquiry activities. Adding the villain, making him challenge the player to “figure it out,” and casting some inquiry levels as boss fights with the villain (not described above) made a substantial difference. These changes have pulled the inquiry activities into the narrative and the students have responded positively. The narrative context motivates and provides meaning to the inquiry activity (Dickey, 2006). The same can be said for how the narrative in *Beanstalk* envelops the inquiry activities.

While we believe that the educational goals that we are pursuing can be integrated in a synergistic way, many questions remain unanswered. As mentioned, we view the current versions of *Beanstalk* and *Teeter Totter Go* primarily as platforms for further investigation. For example, inquiry is important for science learning, but how can it best be integrated in a way that supports the narrative context of the game and moves it forward? Further, SEL is important, but if help seeking is more fun in a narrative context (e.g., because of wise cracks by Chicken and Crow), might it become a distraction? Does learning SEL skills while learning content and inquiry impose too much cognitive load? Does integrating SEL and content learning promote a healthier environment for learning? Does collaborative inquiry indeed provide good opportunities for social-emotional development? We plan to address questions like these through experiments, both in schools and through crowdsourcing (Andersen et al., 2011; Lomas, Forlizzi, & Koedinger, 2013). We anticipate that these experiments will yield interesting insight as to whether collaborative inquiry and SEL can be supported effectively in a game and whether they mutually reinforce each other.

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Patterns of play: Understanding computational thinking through game design

Gabriella Anton, Shannon Harris, Amanda Ochsner, Allison Salmon, Meagan Rothschild,
Matthew Berland, Kurt Squire, University of Wisconsin-Madison
gabby.anton@gmail.com, shannonharris.research@gmail.com, allison@learninggamesnetwork.org, amanda.ochsner@gmail.com, meagan.rothschild@gmail.com, mberland@wisc.edu, kdsquire@wisc.edu

Abstract: While computational thinking and computer science skills are among the most valuable, sought after skills in the digital age, they are also some of the most challenging to learn. Because a vast majority of youth play videogames, using game design as an entry point for programming skills shows promise for encouraging more young learners to pursue careers in computer science and technology (Hayes & Games, 2008). Our research team at the University of Wisconsin-Madison has developed a game design curriculum around the game design software *Kodu*, fostering interest-driven learning of computational thinking. Based on data from 76 participants, results show kode complexity increases with time spent designing in *Studio K*, regardless of gender or prior interest in game design or programming. These preliminary findings beg deeper analysis of the patterns of play that may facilitate deeper, more meaningful acquisition of core computational and computer science concepts.

Introduction

Computational devices are becoming increasingly more integrated into myriad facets of our lives. With billions of smartphones, tablets, laptops, and other digital devices, the masses are able to readily access computational powers that were previously only available to mainframes and supercomputers, if even thought to be possible at all. The prevalence of these devices in nearly all facets of modern life necessitates that more people acquire the navigational and computational skills that can enable them to most successfully participate, and even innovate, in society. To accomplish this, it is imperative that more people become literate with digital technologies. This kind of fluency with computation requires more than knowing how to use any particular application or operating system, or even how to program. Instead it requires knowing how to abstract from situations and think computationally (Wing, 2006). People need to understand what computation can do easily and what it cannot do, develop good intuitions about how computation operates within domains of practice (from social software to personalized medicine applications), and be able to use computation to achieve existing goals, and also articulate and execute, new ones. At the same time, the real power of computational thinking lies in that protean power of the computer: creation. If understanding computation is valuable, using computation to build something personally meaningful is quite possibly the best way to get there. Computational thinking (National Academies, 2011; Wing, 2006) describes an ability to answer the question, “What can I build to understand and/or solve this problem?”

Unfortunately, becoming proficient with computational thinking can be difficult, and there are many intimidating challenges that arise for people looking to develop these skills. There is very little instruction in the United States that teaches students how to cross-apply computational thinking. While there are several paths to acquiring computational skills, most involve learning complex computer programming logic and languages. Many students do not have access to computer science courses in high school, and many existing courses emphasize disconnected abstract principles that create powerful barriers to entry (Camp, 1997). Pulimood and Wolz suggest such barriers could be addressed through a pedagogical shift that includes 1) authentic inquiry through creative design; 2) collaborative work mirroring modern media practices; and 3) multidisciplinary approaches to content (2008).

Game Design as the Solution

One way to address the accessibility issues and pedagogical shifts described above is to relay the material through popular digital technologies that can facilitate the framing of computational concepts in more immediately approachable and meaningful ways. Learning environments that are rich in opportunities for students to connect their background knowledge and interests help to anchor and contextualize the meaning of new knowledge, and thus lead to a deeper, more robust form of transfer for students constructing new schemas and conceptual understanding (Bransford & Schwartz, 1999). Videogames, through their broad dissemination, have become more relevant than ever before in youth’s lives, regardless of gender. Games hold great potential to engage underrepresented groups from very early ages, and to help them learn key practices and concepts necessary to effectively pursue computer science careers later in their lives (Hayes and Games, 2008). Games effectively become a medium for change, with interest in the medium leading to an array of literacy practices and reciprocal apprenticeships which can be further applied to facilitate the understanding of concepts in core classes (Gee, 2003; Steinkuehler, 2007;

Black & Steinkuehler, 2009; Squire & Jenkins, 2003).

Similarly, studies of youth designing and developing their own games have showed gains in a wealth of literacy and critical thinking practices (Peppler, Diazgranados, & Warschauer, 2010), and suggest that these practices facilitate the development of computational thinking skills like logic, debugging, and algorithm design (Berland & Lee, 2011). As other 3D programming and design environments, such as *Alice* (Pausch et al., 1995), *Toontalk* (Kahn, 1996), *AgentSheets* (Repenning, 1993), and *Scratch* (Maloney et al., 2010), have shown, a) providing an ever-growing reference collection of fun games to be deconstructed and built upon; b) enabling peers to help one another to progress in skill from beginner to expert; and c) creating safe spaces to learn to program together without fear of harassment or judgment (Resnick et al., 2009) can be powerful supports for learning to think computationally.

Studio K

Building off the successes of previous programming environments and design environments, as well as curricula on game design, our research team at University of Wisconsin-Madison has developed a similar experience around the 3D visual-based programming software, *Kodu*, integrating game design and programming curriculum within an online community to foster interest-driven learning (see Figure 1).

Figure 1: On the left, the Studio K Mission layout webpage.
In the middle, the initial Kodu interface and design environment.
On the right, programming tiles in Kodu, 3D visual-based programming software.

Working in *Studio K*, young designers play, revise, and create games in *Kodu* as they navigate a series of design challenge missions targeting fundamental concepts distilled from the rich literature on videogame design (see Figure 1). Unlike other visual programming languages, *Kodu* enables users to quickly and easily create seemingly complex, aesthetically pleasing games with only minimal knowledge of programming. By inversing the goal of the program from acquiring programming skills to developing games, *Kodu* can enable deeper engagement and more meaningful connections with the content, using interest in and enjoyment of videogames to promote use of increasingly more complex programming and computational thinking skills. The *Studio K* curriculum orients to these goals, using playful, open-ended challenges to ensure that students acquire content in individually relevant and engaging ways.

Methods

The data set for this paper represents learning analytic data from four club settings with a total of 76 students. Each club ranged from 2-4 weeks of active participation with *Studio K*, with 45-90 minutes spent per session. Data are derived from logged interactions with *Studio K* curricula and a modified version of Kodu used to build our ADAGE telemetry architecture (Halverson & Owen, in press). Logged and survey data were analyzed using ANOVAs and linear regression models. Descriptive statistics and correlation data were examined as well. Survey data were collected from students before they began using *Kodu* and the *Studio K* curriculum.

Key survey variables analyzed included sex, age, and 5-point ranged Likert scale statements measuring interest and identity components. These statements included: “I hope to get a job doing something with video games,” “It’s important to know how to program,” “I would be interested in taking more classes on programming,” and “It’s important for me to know how to design video games” while asking users to self-report their answers ranging on scales from strongly agree to strongly disagree (see Table 1, below).

	Strongly Disagree (1)	Disagree (2)	Undecided (3)	Agree (4)	Strongly Agree (5)
I hope to get a job doing something with video games.					
It's important to know how to program.					
I would be interested in taking more classes on programming.					
… design video games					

Table 1: Pre-Curriculum Identity and Interest Survey

Key logging data variables harvested from in-world actions included: timestamps, time spent on specific tasks, number of pages of kode (code in *Kodu)* developed, number of revisions made to kode, frequencies of actor switching (changing from one in-world object to another), unique sensor counts (kode developed that included passive coding concepts), unique action counts (kode developed that included active coding concepts), and kode complexity, which was operationalized by aggregating the unique sensor and action paired variables. Variables were parsed using time stamps; anonymized user IDs; and a combination of time stamps, user IDs, and user plus the specific in-game kodu being manipulated at a given time.

Results

Analysis of ADAGE in-world telemetry data reveal that measures of complexity and game/program quality are not significantly correlated with external measures of interest (See Table 2, below). Specifically, measures of code complexity, revisions, and the number of objects programmed are not significantly correlated with the interest measures in our survey (*likelihood of future courses on programming*, *importance of learning to program*, and *interest in having a job related to game design*).

			revision count	actor switching	Kode_Complexity
Spearman's rho	revision count	Correlation Coefficient	1.000	.249**	.291**
		Sig. (2-tailed)	.	.000	.000
		N	4988	4988	4988
	actor switching	Correlation Coefficient	.249**	1.000	.159**
		Sig. (2-tailed)	.000	.	.000
		N	4988	4988	4988
	Kode_Complexity	Correlation Coefficient	.291**	.159**	1.000
		Sig. (2-tailed)	.000	.000	.
		N	4988	4988	4988
	How well do the following statements describe you?–I would be interested in taking more classes on programming.	Correlation Coefficient	.098	-.008	-.158
		Sig. (2-tailed)	.399	.943	.172
		N	76	76	76
	How well do the following statements describe you?–I hope to get a job doing something with video games.	Correlation Coefficient	-.022	-.131	-.087
		Sig. (2-tailed)	.853	.259	.454
		N	76	76	76
	How well do the following statements describe you?–It?s important to me to know how to program.	Correlation Coefficient	.015	-.137	-.097
		Sig. (2-tailed)	.895	.240	.406
		N	76	76	76

Table 2: Logged in-World and Survey Response Correlation Data

In addition to finding no significant correlations among complexity of game design projects and interest in game design/programming, we also found no significant relationship between gender and kode complexity. In fact, the girls created slightly more complex code than the boys (See Figure 2, below).

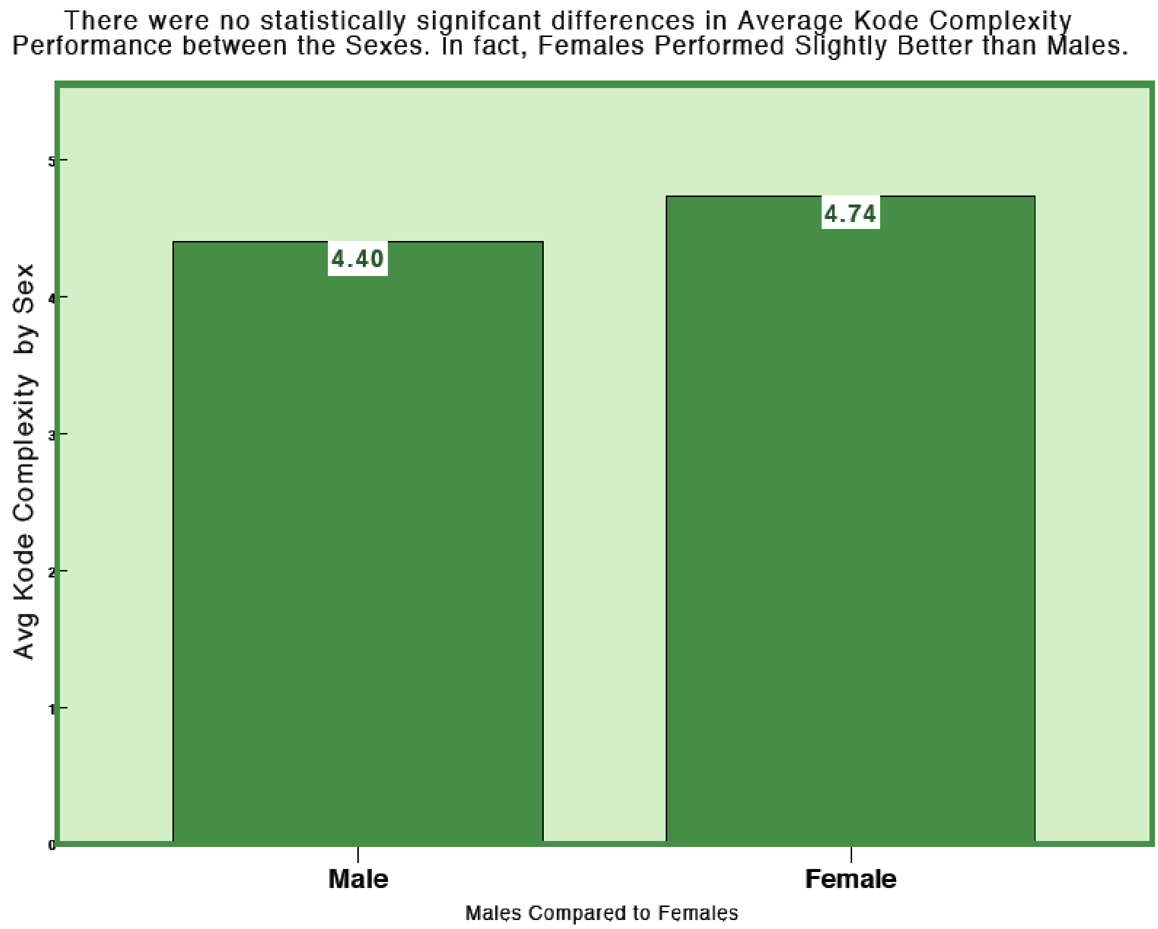

Figure 2: Male versus Female Average Kode Complexity Comparison

Additionally, a linear regression model demonstrates that kode complexity is likely to increase over time, with higher average skill levels developing across all users and significantly increasing with the number of days spent with the curriculum ($p < .001$). No significant findings were discovered using ANOVAs by comparing club sites, number of pages of total kode, or aggregated unique sensor and action counts

Discussion

Analysis of initial telemetry data reveals that as young learners spend more time making games in *Kodu* using the *Studio K* game design curriculum, the complexity of their kode increases. These initial results suggest that *Studio K* provides learning benefits for users, represented through the increasing complexity of kode. Interestingly, these improvements remain regardless of gender and regardless of initial interest in both game design and programming. These two final insignificant correlations, gender and interest correlated with kode complexity, are most interesting, as they suggest that *Studio K* may be effective with a broader audience than is typically seen in game development or computer science.

These results lead into other lines of questioning, begging analysis on examining other measures of learning throughout the curriculum and more concretely defining the learning practices that are occurring throughout use of the program. Next steps include examining the relationship between kode complexity and other computational thinking practices, like debugging patterns. As we begin to further break apart the patterns of play within game design, learning profiles may become illuminated. Since the nature of the program is learning through open-ended, interest-driven challenges, examination of these patterns may show the natural progression through these basic computer science concepts; information that may inform meaningful iterations on the structure and function of the *Studio K* curriculum.

The primary goal of *Studio K* is to provide a unique learning experience to foster interest in computer science or programming through the initial exploration of games. The playful, open-ended challenges may support a broader range of interests and learning styles resulting in a higher success rate among all students, regardless of gender or prior interests in the content area.

These initial results suggest that the initial *Studio K* framework can be leveraged to provide a more enriching experience targeting underrepresented populations. Future research and product iteration will focus on identifying and bolstering the features that support successful acquisition of practices across a wide audience and building new tools that may be absent from the current support structure. These future redesigns may be structured around providing more concrete, meaningful trajectories that players can take through the *Studio K* curriculum that will support their skills, interests, and learning patterns in game design and programming. Players may ultimately complete all curriculum challenges, but they may originally follow their own trajectory. This cyclical process of design, player testing and data analysis, and then another iteration of design allows us to incorporate many of the essential components of design-based research--flexible design revisions and the study of multiple dependent variables, as well as trying to capture the complexities that arise out of capturing and understanding social interaction (Barab & Squire, 2004). Our iterations seek to improve early designs by testing and iteration, informed by analysis of not just what can be concluded about the learners' reasoning, but also the learning environment as a whole (Cobb et al., 2003).

This project will enable the team to aim for some of the true goals of design-based research--to not just show how a design works for a particular project, but to generate claims about learning and contribute new knowledge to the field (Barab & Squire, 2004). We hope that research on *Studio K* will not only reveal computational thinking benefits for users but also important insights about teaching game design and introductory computer programming concepts.

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Promoting embodied learning through virtual and real world gaming experiences

Audrey Aronowsky, Beth Sanzenbacher, Field Museum of Natural History
aaronowsky@fieldmuseum.org, bsanzenbacher@fieldmuseum.org
Mark Childs, Coventry University, aa5575@coventry.ac.uk
Anna Peachey, Eygus Ltd., anna@eygus.co.uk
Krystal Villanosa, Northwestern University, kvillanosa@u.northwestern.edu
Johanna Thompson, Kenneth D. Angielczyk, Field Museum of Natural History
jthompson@fieldmuseum.org, kangielczyk@fieldmuseum.org

Abstract: Embodied experiences can be important for changing attitudes, deepening understanding, and increasing science process skills. The Field Museum is interested in best practices for using and combining digital and analog moments for STEM learning. Recent studies support the use of digital tools, particularly virtual worlds, for embodied learning. Other studies show that physical role-playing activities can lead to embodied learning. The choice of virtual or physical experiences to trigger embodied learning should tie directly to learning goals. Here we highlight two activities from "I Dig Tanzania" that facilitated embodied learning: one that was most effective as a role-play and the other as a virtual world activity. External analysis documents the affective and content gains made by our teen participants. These results and participant feedback will be used to initiate a conversation about the importance of embodiment in achieving learning goals, particularly those that relate to attitudes and process.

Introduction

I Dig Science (IDSci) is an intensive summer program for underserved teens that synthesizes learning in a 3D simulation of a fossil excavation with a synchronous paleontology expedition in Africa and privileged access to a natural history museum. IDSci provides an opportunity for teens to develop their problem solving skills in a rich and engaging scientific context by having the embodied experience of being a scientist and using a problem-based learning approach to investigate real scientific and social problems. Numerous studies have shown that providing opportunities for young people to participate in the scientific process is critical to their future enjoyment of, and engagement with, science (e.g. Lederman, 1992; Gibson and Chase, 2002). Through an integrated suite of virtual and real world activities, teens used digital and museum resources to generate and test hypotheses about the largest mass extinction event in Earth history and environmental and social issues confronting Tanzanian society. By encouraging teens to mimic the work of scientists and situating the learning at natural history museums, IDSci provides the kind of authentic experience that is critical to facilitating higher order learning (e.g., Brown et al, 1989).

Embodied Learning

There is a large amount of literature on the affordances of virtual worlds for learning (e.g., Rickel and Johnson, 2000; Dalgarno and Lee, 2010). Among these affordances, great importance is ascribed to the ability of virtual worlds to provide learners with embodied experiences (Taylor, 2002); embodiment being the identification of the learner with their avatar or virtual character and that character's virtual experiences. Embodiment within a virtual world is possible because the "mental representation of the body" is not necessarily located in the physical body but can, in fact, be located elsewhere (Biocca, 1997) due to the plasticity of most people's body schema. This can be seen in the physical world in phenomena like the rubber hand illusion (New Scientist, 2009), in which a participant's hand is hidden and a fake hand placed within their field of view. The two hands are then stroked simultaneously and even though it is obvious that the rubber hand is not real, about two-thirds of participants transpose a feeling of ownership to it. In virtual worlds, the avatar on the screen becomes the user's extended body such that "users do not simply roam through the space as 'mind', but find themselves grounded in the practice of the body, and thus in the world" (Taylor, 2002; p.42). However, as with the rubber hand illusion, embodiment within a virtual world only occurs in approximately two-thirds to three-quarters of participants (Heeter,1995; p.200). Why a minority do not experience embodiment is not understood, but it may stem from some participants being "so strongly situated in the real world and their real body that they have a difficult time becoming involved in the virtual world". Heeter's use of the word "situated" specifically describes the experience of being embodied within a space, rather than simply "located" within it, a distinction established by Merleau-Ponty (Smith, 2007; p.16).

Embodiment has the potential to allow learners see themselves from a different perspective and is potentially transformative. This is particularly important for the underserved urban teens targeted by IDSci, who have never thought of themselves as scientists or even problem-solvers. Additionally, virtual environments can be highly motivating for many students (Sancho et al., 2009), and underserved male teens show particular affinity for them

(Steinkuehler et al., 2012). For other learners, group role-playing exercises can be an effective way to promote embodiment and learning (McSharry and Jones, 2000). Recognizing that embodiment can have different triggers for different learners, and that it may not be possible for all learners, IDSci takes a blended approach, leveraging the affordances of 3D virtual worlds but also including real world role-playing activities and placing the learning experiences in a natural history museum.

The Program

I Dig Tanzania 2012 (IDT) was the most recent iteration of the I Dig Science series (launched as a collaboration between the Field Museum of Natural History and Global Kids in 2008). During IDT, 16 teens in Chicago participated in a 3-week program to discover the causes, effects, and implications of the end-Permian mass extinction, and to explore environmental and social issues in Tanzania. IDT made use of four complementary platforms: 1) the virtual world Second Life; 2) videos, photos and satellite calls from the expedition team and local African colleagues and students; 3) behind-the-scenes, exhibit-based and real-world activities at natural history museums; and 4) a suite of digital technologies (e.g. Google Docs, iMovie, Tumblr, Skype). These four platforms were integrated seamlessly to provide robust embodied experiences in which teens could work and learn about the larger world in which they live. The evaluation of the IDT program (Childs and Peachey, in preparation) found that Second Life and the real-world activities were particularly effective in providing teens with embodied opportunities to achieve learning goals. The affordances of Second Life that promote embodiment center around two aspects of the virtual world, the use of space and the presence of the avatar. The space within the virtual world is three-dimensional and navigable, and responds to the actions of the user through the movement of objects and responses of objects to the actions of the user. The avatar not only provides a mechanism for interaction with the environment, but is also personalizable. The sense of the reality of this space was developed through activities promoting movement and interaction, such as a soccer game. Although appearing to be purely a fun activity, this helps the learners to coordinate the movement of their avatar and interact with the soccer ball. Once the ability to move becomes natural, the technology appears less intrusive to the user, and the sense of location within the space becomes stronger. Similarly, early on in the program, the learners are given an activity which requires them to modify their avatar (to adapt to its environment). This introduces the learners to the sense of the avatar being personalizable, and through its alteration they feel ownership over it. It is then not only a means for interaction, it is an extension of their body within the space, and represents them as an individual to the other learners.

Methods

Seven methods were used as sources for research data. 1) Participants in the program were given fifteen minutes at the end of every day to update their program blogs. This was a directed activity, with questions and topics provided by the facilitators. 2) Learning activities directed the development of Googlebooks, which were created in groups and provided learning content for review. 3) Much of the physical activity within the program was filmed, creating a resource for non-participant observation of interaction that includes the capture of subtle indicators such as body language. 4) Participant interaction within the virtual world was chatlogged and many object interactions were logged, so that virtual interaction and collaboration could be tracked and coded, and 5) inworld machinima was captured for many of the SL activities. 6) A survey was administered at the beginning of the program and another shortly before the close to capture comparative reflections as data at a point in time. 7) Finally, four participants were selected for interviews to explore more detailed insights, perceptions and beliefs about their experience on the basis of their activity profiles across the program. A combination of these seven methods allowed for triangulation and some internal verification. However the quantity of data presented a significant time and resource challenge, so a pragmatic approach was taken in which the core sources (blogs, chatlogs, surveys) were the primary items analyzed, with evidence from other sources such as interviews and object interactions to used to corroborate and triangulate the key findings.

Human-Wildlife Conflict

Human-wildlife conflict “is a serious obstacle to wildlife conservation worldwide and is becoming more prevalent as human populations increase, development expands, the global climate changes and other human and environmental factors put people and wildlife in greater direct competition for a shrinking resource base” (HWCC, 2012, para. 1). Interdisciplinary collaboration and an understanding between all stakeholders is vital to address and mitigate these conflicts (HWCC, 2012). Learning objectives for the human-wildlife conflict activity included getting learners to understand negative and positive aspects of local wildlife, to understand the connections between different species (human, plant and animal), and to make observations and gather data to collaboratively find a solution to the problem. To achieve these goals, the teens participated in three complementary activities. First, participants embarked on an exhibit-based photo scavenger hunt to explore the size and scope of the African large mammal fauna, with the goal of giving all participants a common knowledge base about African wildlife. Then, participants Skyped with students from the University of Dar es Salaam in Tanzania to discuss local human-wildlife conflict issues and how they affect life in Tanzania. Finally, IDSci participants engaged in a Second Life activity in which they became Tanzanian farmers, and had to manage their local wildlife.

In the Second Life activity, participants virtually planted and grew crops that were then trampled by a virtual elephant, mimicking the experiences of real farmers in certain parts of Tanzania. When challenged with problem of elephants trampling their crops, the participants first collectively decided to build a wall around their crops (see Figure 1a), but this had the unintended consequence of disrupting the ecosystem, resulting in their crops dying. The participants, who were now heavily invested in their farms, became increasingly frustrated in the methods that they were attempting to use to solve the elephant problem. Through close examination of their virtual environment, participants observed that some of the Acacia trees on their farms were healthy and covered in ants (see Figure 1b), but most were dying and covered with stem-boring beetles. In the group discussion that followed, participants postulated that Acacia trees were vital for crop survival (the trees keep the soil from eroding and maintain nutrient levels). They learned that when elephants graze on Acacia trees they stimulate the trees to produce more nectar which feeds the ants, and, in return, the ants protect the trees from predators. When the trees are not being grazed on by elephants, they produce less nectar and the ants depart. This leaves the trees vulnerable to predators and parasites, eventually causing the trees' death and the failure of nearby crops (Palmer et. al., 2008). Upon completion of the activities participants discussed practical and effective ways for Tanzanian farmers to keep the ecosystem intact while protecting their crops from elephants.

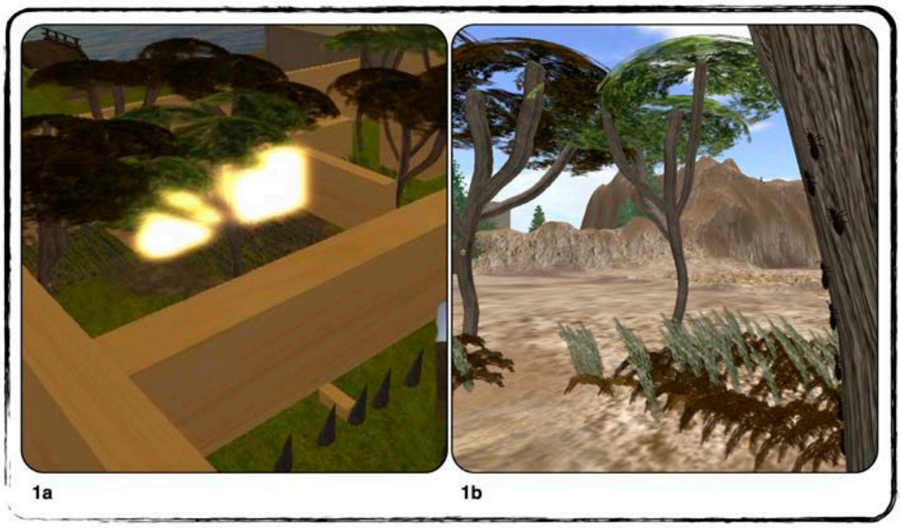

Figure 1: The human-wildlife conflict activity in Second Life a) wall built by teen participants to keep the elephant away from their crops and b) ants on healthy Acacia tree.

Evaluation of the human-wildlife conflict activities found that 13 of the 15 teen participants demonstrated an understanding of the common conflicts between humans and wild animals and 14 of the 15 participants demonstrated an understanding that all species are connected in some way. Evaluation of the teens' blogs showed that the Second Life activity had the greatest impact on their learning (Childs and Peachey, in preparation). Some examples from participants' blogs include:

Being a farmer in Second Life reveals the intricate and delicate scale on which life balances. Each species in some way helps, or hinders, another; no matter how indirectly. What we experienced on Second Life mirrored a trouble of real Tanzanian farmers.

As we planted crops in Second Life, we were attacked by an elephant. In order to combat our foe, we built a fence around our crops. After that all our plants started to die. We learned that the trees need the elephants to survive, and without them our crops died.

These statements suggest that the teens began to feel the competition between farmer and wildlife, seeing the elephant as a "foe" to be combated, as opposed to only understanding it in an abstract sense. It also provided an empathic window into the worries and troubles of a Tanzanian farmer trying to make a living in a harsh environment. The virtual world experiences provided authenticity and, to some extent, gave them a real experience upon which they could draw. This experiential component not only enabled the teens to actively utilize the principles and skills being discussed, but also incorporated an emotional component to their engagement (Childs and Peachey, in preparation).

Clean water

Access to clean water is a major problem that confronts Tanzanian society. “Only 54% of the population has access to improved water supplies...women and children spend on average over two hours a day collecting water and up to seven hours in remote areas” and “20,000 children die before the age of five each year in Tanzania due to diarrheal diseases” (WaterAid, 2012, Context section, para. 1). Given the scale of the problem in Tanzania and the impact it has on health and quality of life, it is imperative that people become engaged with this issue to find sustainable solutions. The learning objective for the clean water activity was to understand how lack of access to clean water affects Tanzanians.” To achieve this, the teens again participated in three complementary activities.

First, the teens watched a video from a Peace Corps veteran who was active in the children’s aid-focused NGO World Vision, in which she shared stories from her work helping a Maasai village access clean water. The video was intended to introduce the concept of clean water and provide a common knowledge base for all participants. Then, participants Skyped with students from the University of Dar es Salaam to discuss access to clean water in both urban and rural communities in Tanzania. Finally, participants played a real-world game in which they assumed the role of an African youth tasked with providing clean water to his/her family (see Figure 2). The game’s objective was to carry a 5-gallon bucket of water a distance of 0.5 miles around the Museum. Participants competed with one another to see who could carry their bucket of water the fastest while losing the least water in the process. During the walk, participants were approached by program facilitators who presented them with scenario cards (see Figure 3). Upon completion of the activities, participants discussed the issue of water access and brainstormed possible solutions that would be practical and effective for the Tanzanian population.

Figure 2: Teen participants competing in the water game.

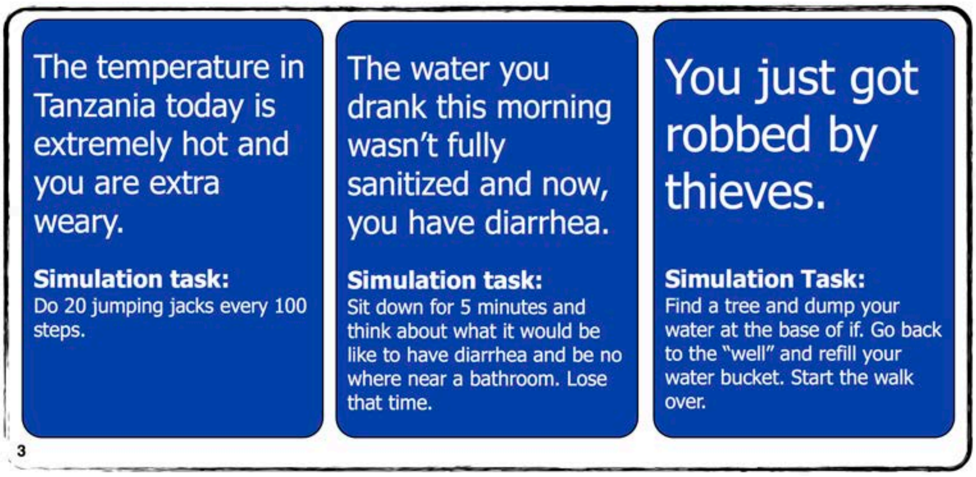

Figure 3: Water game scenario cards.

Although the learning objective from the clean water activities was not formally evaluated, it was clear that the real-world game had the greatest impact on participant learning (Childs and Peachey, in preparation). This is shown in excerpts from participant blogs and post-program interviews.

Blog excerpt: The most fun things we have done this week is carrying the water around the museum. That really opened my eyes to what people in Africa have to do. Experiencing the water carrying process impacted me much more than just seeing pictures of what other people have to do to get water.

Although physically demanding, participants felt that the activity was very instructive in that it gave them a particular insight into the experiences of Tanzanians (Childs and Peachey, in preparation). Similar to the human-wildlife conflict activity in Second Life, the real-world game provided teens with the direct experience needed to gain a deeper understanding of the problem, which resulted in them empathizing with the people that are directly affected by it.

Interview excerpt: *Kathy*: unless you actually do it, you don't really… at least I'm like "oh it's not that bad, I'm sure they're just complaining" but when we had to carry that bucket of water, 5 gallons, around, you definitely realize what…

Ray: it's a lot. Going around the museum I think it's probably a mile or two, max. And then we got robbed and we had to go all the way back and we had to go around again.

Kathy: and then we got attacked by birds that weren't even supposed to be there.

Ray: It was hard.

Discussion

As these two examples from the IDT program show, embodied experiences can be important for changing attitudes, deepening understanding and increasing science process skills. Participants embodied a Tanzanian farmer or a local seeking clean water to experience first-hand the problems these groups face. These experiences allowed participants to gain a better understanding of each problem and then use personal examples to propose logical solutions. Whether the experience that led to embodiment was a real-world role-play or took place in a virtual world did not seem to impact learning. Instead, each experience was effective at promoting embodiment because it allowed participants to gain insight into the problem by emulating the physical behavior of those whose perspective they were modeling. "Physical" is appropriate in this context, even for the virtual world activity, due to the degree of embodiment experienced by the participants.

In the case of clean water, insight about the plight of African youth came from the weight of the water and the physical challenge of the task. Those aspects were best realized through a real-world role-play, which allowed our American teen participants to embody their African peers' situation, even for just 30 minutes. At the outset, the task seemed simple: carry a bucket around the building (and, indeed, the task was far easier than the conditions and distances that some African youth deal with on a daily basis). Although the task was physically daunting on its own (carrying the water a set distance); participants grew increasingly frustrated and upset as scenario cards were dealt by facilitators. Each scenario was based on authentic accounts from African youth, but seemed random and unjust to our American participants. The combination of the task and scenarios helped participants to understand that a seemingly simple task can be a great challenge when it is undertaken by vulnerable people who are subjected to both injustices and stochastic events. The physicality of the role-play game helped us to surpass our simple learning goal of understanding how lack of access to clean water affects Tanzanians. Additionally, we were able to raise awareness about the plight of African youth who seek clean water and to change attitudes about the problem of clean water. Pre-participation, American teens thought that their African peers were "just complaining" about their task and access to clean water. But post-participation, American teens gained an understanding that, in their own words, was truly transformational for them and, for some, was the most memorable experience of their three-week program (Childs and Peachey, in preparation).

In the case of human-animal conflict, insight came from the trial and error process and a holistic understanding of the African ecosystem provided by the virtual world simulation. Those features were best realized with a digital activity in which participants could rapidly see the results of different methods for excluding elephants and make detailed observations of the simulated ecosystem. It would have been possible to design a similar activity using analog methods, such as illustrated game cards or physical role-play, but those methods would have made it more challenging for learners to see the whole picture rapidly and synchronously. In this activity, placing the learners within a virtual world scenario was a more realistic and accurate replication of the physical world environment than an alternative real-world activity would have been. The effort in typing the phrase "grow crops", although less than physically sowing them, still incurred a cost to participants. The impact of seeing the facilitator's avatar (an elephant) physically trampling those crops was less abstract than an analog method would have been, resulting in a stronger emotional reaction. Perhaps most importantly, the visual complexity of the virtual world enabled clues to the solution to be placed subtly within the environment, requiring the participants to replicate real world scientific processes of investigation (e.g., iterative observation and problem-solving), whereas any analog method, such as activity cards, would have foregrounded the answers.

Conclusion

The effectiveness of both activities described above, whether situated in the physical or the virtual, is related to the degree to which the activity can embody the key elements of the learning goals. No proxy experience can replicate entirely the experience being modeled, but by identifying the essential aspects that need to be communicated, and by choosing the most effective platform to convey these aspects, an effective learning experience can be constructed. Because of the effects of embodiment within a virtual world, physical does not necessarily mean more real. Neither does more technological mean more engaging, even for so-called "net generation" learners. For most of these learners, and increasingly for previous generations who are becoming more adept at using these platforms, the distinction between "technology" and "not technology" has disappeared; there are simply a range of different activities in which to take part, which may appear on a screen, or may be in the physical world, depending on which is most appropriate at the time. Whether real or virtual, embodied experiences clearly have a direct impact on how youth construct knowledge and engage in meaning-making and sensemaking. Therefore, providing for embodied experiences should be considered as an instructional strategy by program designers and facilitators. Finding the right reality in which to set learning activities, without a priori assumptions about which is the most appropriate, and finding the right balance of realities, has proven to be the best approach for the IDT program.

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Working Through Impulse: Assessment of Emergent Learning in a Physics Game

Jodi Asbell-Clarke, Elizabeth Rowe, Elisabeth Sylvan, TERC
Jodi_Asbell-Clarke@terc.edu, Elizabeth_Rowe@terc.edu, Elisabeth_Sylvan@terc.edu
Ryan S.J.d. Baker, Teachers College, Columbia University, baker2@exchange.tc.columbia.edu

Abstract: Games may offer a unique opportunity to support and observe intuitive learning that could be foundational for further STEM learning. This paper reports on research of players' activity in a game, *Impulse*, that immerses players in the physical laws of Newtonian motion. The aim of this research is to seek evidence of tacit knowledge as it develops through gameplay to see if that tacit knowledge development can eventually be related to players' learning of the underlying science. This paper reports on the identification of a set of strategic moves that players develop in *Impulse* as they advance in the game and discusses how those strategic moves may be indicators of implicit cognitive strategies and knowledge develop over time in the game. Researchers are analyzing video from playtesting and engineering features from associated click data to predict strategic moves hypothesized to reflect tacit understanding of Newtonian motion.

Introduction

There is a growing body of evidence that games foster quality STEM learning experiences (Asbell-Clarke et al., 2012; National Research Council, 2011; Steinkuehler & Duncan, 2008). Well-designed games require active participation, are challenging and designed with clear goals in mind, provide immediate feedback, introduce new concepts in a logical progression, and allow players to take risks and learn from their mistakes with minimal consequence (Shute, Rieber, & Van Eck, 2011; Gee, 2009; Ke, 2009). Furthermore, well-designed games can be used to promote such 21st century skills as creativity and innovation, critical thinking and problem solving, and flexibility and adaptability (Thomas & Brown, 2011). With 97% of US youth ages 12–17 (boys *and* girls) playing video games (Lenhart et al., 2008), and black and Hispanic students accessing the Internet through mobile phones more than their white counterparts (Shuler, 2009), digital games (particularly using wireless devices such as phones and tablets) have real potential as educational tools, especially for reaching learners who are most at risk of becoming "checked out" of school.

Our team is funded by the National Science Foundation to design a series of web and mobile games that focus on high-school science concepts drawn from U.S. standards for science education. Our games use simple game mechanics grounded in the laws of nature and principles of science, thereby allowing players to dwell in scientific phenomena. We are studying how these games can be natural, in situ forms of assessments of learning.

We are focusing on how games may support and enable measurement of intuitive, or tacit, knowledge that may provide an important foundation for more explicit learning that takes place in formal settings. We draw our framework from the notion of *indwelling* (Polanyi, 1966) where people make sense of the system they embody by building a set of subsidiary experiences that become the basis of their intuitive understandings. Thomas and Brown (2011) have more recently emphasized that examination of the indwelling that happens in games and other digital media may be very important to understanding the new culture of learning that is around us.

Framework of Game-Based Assessment and Tacit Knowledge Development

Much of the research in game-based assessment uses an Evidence Centered Design (ECD) framework. ECD models seek to establish a logically coherent, evidence-based argument between the domain being assessed and assessment task design and interpretation [Mislevy & Haertel, 2006]. While this work is important for moving towards formalized assessment in games, our approach looks at emergent behaviors that may be unique to games. Rather than facilitating assessment through constrained interactions, we enable players to dwell, survive, and advance in increasingly complex and difficult physical settings and watch for the strategy development that occurs naturally.

Our research begins with a method analogous to a grounded theory approach to defining our task model, where we make detailed observations of players dwelling in the game and iteratively hone in on themes or strategies that emerge from the observations to describe players' experience in the game. It is from those empirically grounded strategies that we will then build our evidence-based assessments. We use this approach because we are interested in the learning that takes place in games that may be emergent, and not necessarily predicted by the designers and other educators. Our framework places this emergent learning as central to tacit knowledge development that takes place in voluntary games that may be useful for educators to leverage for formal learning.

We are specifically focusing on evidence of strategies that emerge from gameplay that demonstrate tacit understanding of concepts and skills in science, which may not be explicit to the learner. These ideas may be so engrained that they become second nature and thus very difficult to capture. Polanyi (1966) argues however that tacit knowledge is foundational to explicit knowledge. Learners can carry misconceptions (sometimes due to the non-ideal factors in our world such as friction) about fundamental physics that can interfere with their explicit learning about the principles of motion (McCloskey, 1983). Game players do not necessarily perceive their game-based learning as connected to real-world phenomena (Sylvan et al., 2013), In our research, we must look for indicators evident in players game activities and then find ways to validate their inferences that the indicators do indeed represent key cognitive developments.

This paper describes our process of defining emergent strategies within a physics-based game. This is the first step in our longer process of developing game-based science assessments for high school game players. We argue that by identifying cognitive strategies that players develop while dwelling in games that portray and require predictions of accurate scientific phenomenon, we may be able to develop a new, informative, and accessible type of science learning assessments for education. This paper demonstrates the first steps in this process using the game, *Impulse*, developed by EdGE to enable players' indwelling and playing in the context of a physics simulation.

Studying tacit knowledge development in the Game *Impulse*

In *Impulse*, players must predict the motion of the balls around them to survive in a game using very simple game mechanic that is repeated over and over in increasingly difficult contexts. The motion of all of the balls obeys Newton's laws of motion and gravitation. We are examining whether *Impulse* players, while advancing in the game, may be developing and mastering an intuitive sense of Newton's laws that we can systematically measure. Once we can accurately detect what they tacitly understand about Newtonian mechanics from their gameplay, we will use this method to examine how this tacit knowledge develops and how players can build connections between intuitive knowledge they build in games and examples of similar science outside the game.

The process of developing assessments for *Impulse* is a two-phase process, analogous to approaches previously used to develop automated assessments for constructs such as science inquiry skill in simulations (Sao Pedro et al., 2012), and disengaged behaviors in intelligent tutoring systems (Baker et al., 2008). First, human judgment is used to infer a range of learner strategies and approaches within log data. The set of human judgments obtained will then be used as the basis for using data mining (Baker & Yacef, 2009) to create prediction models which can automatically infer the strategies being used by learners, without requiring intensive hand coding of data.

Design of Impulse

Impulse is designed for play on computers, tables, and smartphones Players are immersed in a sea of ambient balls obeying Newton's Laws (see Figure 1). EdGE, and partners GameGurus, developed the game as a proof of concept to understand how a free-choice game can be used to foster and measure intuitive learning about the science. This is different than the large body of research looking at learning and assessment in games within classrooms (Squire & Barab, 2004; Ketelhut & Nelson, 2010; Shute, et al. 2010).

In *Impulse,* players must navigate their own ball (green) to a moving goal, while avoiding collisions with an increasing numbers of ambient balls each new level. The player can impart an impulse to move any of the balls with a touch or click on the screen. Any nearby balls move as they experience the force of the impulse imparted by a player's click. There are also gravitational forces between balls and elastic collisions between ambient balls. A collision between the player's ball and an ambient ball causes an explosion and sends the player back to a previous checkpoint. As the player progresses through Impulse, more balls are added to the screen. At each checkpoint, a new type of ball (different color, size, and mass) is introduced.

Figure 1: The green player ball (near center) in a sea of ambient balls of varying mass in *Impulse*

Players use energy with each impulse. They may use up to 20 impulses and then their energy is replenished if they reach the goal, or they drift without any control. Players may conserve energy, and earn a higher score, by being strategic in when they use the Impulse.

Survival in higher levels of *Impulse* would be virtually impossible without the ability to predict the motion of the balls. While navigating through a sea of up to 22 balls that are colliding with each other, and are attracted to each other through gravity, players need to “study” the behavior of those balls. They need to be able to predict their motion so that they can avoid them as they travel to the goal.

More specifically, the motion that must be predicted can be described by Newton’s First and Second Laws of Motion:

1. Newton’s First Law of Motion (**NFL**) describes how an object will stay at rest or in (straight-line) motion, unperturbed, unless acted upon by a force. This sounds simple, but is not intuitive for much of the public, particularly in cases of circular motion (McCloskey, 1983)

2. Newton’s Second Law of Motion (**NSL**) describes the relationship among force, mass, and acceleration. Simply, heavier objects are harder to move than light objects. The formal expression commonly taught in school is **F**orce = **m**ass x **a**cceleration.

Newtonian mechanics bely the intuition of many learners, as evidenced by research that shows that in general the public’s high school understanding of these concepts are inaccurate and not greatly improved by traditional higher educational instruction (Emarat & Johnston, 2002). Basic misconceptions are typically that constant motion requires constant force (this is not true by Newton’s first law) and that a constant force will cause constant velocity (this is not true, by Newton’s second law the force will cause an acceleration which is a change in velocity).

Identifying Emergent Cognitive Strategies in Impulse

Knowing that the game is designed to have players predict Newton’s first and second laws of motions, we sought to identify cognitive strategies we could observe players using to deal with these underlying behaviors of the balls. We describe here the process we are using to identify the strategies from a series of video captures with think-alouds and interviews from a set of high school students playing the game outside of class time.

Developing System to Code Cognitive Strategies

This paper reports on five playtesting sessions with 15 high school students (3 female) recruited predominantly from urban schools in the U.S. Northeast as well as various other informal settings. Players were observed (and video recorded) while playing the game, and several provided follow-up interviews. Two coders, one a game designer with a physics background and a researcher with no physics background, independently watched segments from the video recordings to develop an initial set of strategic moves. Players were recorded with Silverback software (silverbackapp.com) while playing *Impulse*. This software captures video of the players' onscreen game activities, and audio and video of the player's face. We also recorded a digital log that includes these *raw features*: (a) event type (click, collision, goal reached); (b) timestamp; (c) location of each click, ball, and the goal; (d) mass of each ball in the game space; (e) game level; and (f) player ID. The coding process relies not only on clicks, but also other screen activity such as mouseovers and player commentary.

Researchers used the mouseovers, where players' cursor was visible indicating on the screen their focus of attention, to help code intentions such as purposeful floating--a deliberate act of letting the player ball move under the influence of no forces. We encouraged players to "think aloud", discussing their game play with a friend or the facilitator. In some cases we conducted direct interviews with players to ask them about their moves and strategies, in order to confirm and refine our inferences about the thought processes behind players' moves.

Over 20 randomly selected three-minute segments, two researchers iterated on the coding scheme to introduce all the moves that they observed and provide codes that they could consistently agree upon to describe each move (see Figure 2).

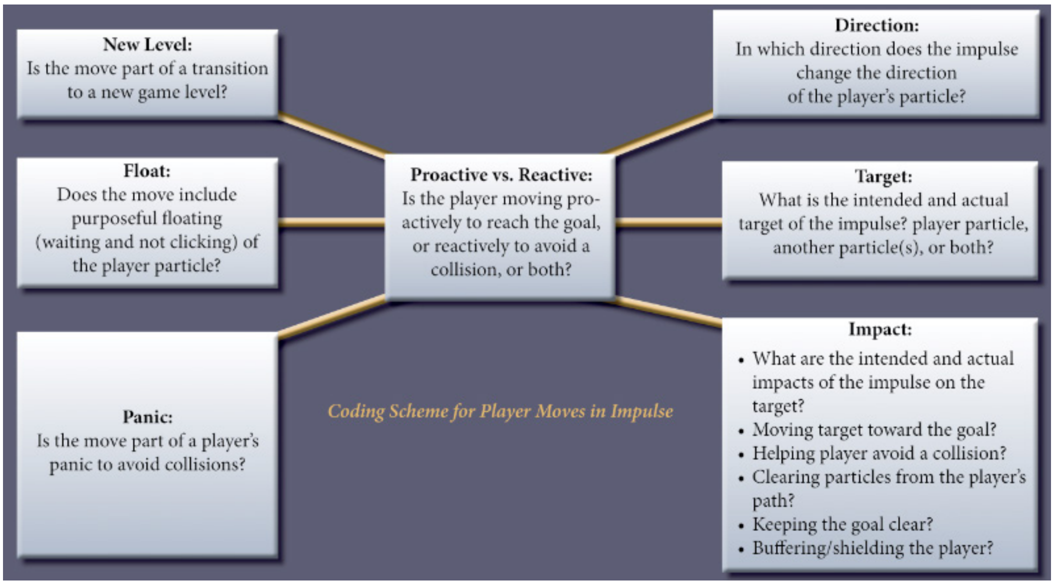

Figure 2: Codes used on players' moves to build towards cognitive strategies

Iterative refinements over several trials have led to improvements in the level of agreement after accounting for chance (Cohen's Kappa). In the approximately 500 clicks coded to date, Cohen's Kappa ranges from 0.49 for Intended Impact to 0.77 for Target. Within the Intended Impact coding, however, Kappas for many individual codes such as Toward Goal, Avoiding Collision, Buffering, and Opposing exceed 0.70. We are using results from this round of coding to further refine the coding system and train to a higher level of agreement.

Based on video observations, think-alouds, and interviews, we have identified the following cognitive strategies that we hypothesize will emerge as distinct sequences of strategic moves in the log data from *Impulse,* which can be automatically identified by models developed through educational data mining. We will also look for other strategies that can be linked with tacit knowledge development about Newton's Laws of Motion.

1. <u>Push to Goal</u>. This is a baseline novice move. Nearly all players use a push-to-goal strategy at times, where they use the impulse along a direct path towards the goal. This indicates at least a baseline concept of the game mechanic and, to some weak (and probably uninteresting) extent, an understanding of straight-line motion under NFL.

2. <u>Oppose Motion</u>. Many players directly oppose straight-line motion with their impulse, particularly at the start of a new level. They clearly demonstrate the need for providing the impulse in the opposite direction of the ball's straight-line motion in order to stop it.

3. <u>Redirect Around Balls</u>. As players become more expert in the game, they are able to predict the motion of the ambient balls and strategically redirect their ball's motion to avoid them.

4. Wait for Balls to Clump and Move. As players become aware of the interactions between the ambient balls, they realize that the sea of balls may change and create a new, unobstructed path towards the goal if they wait.

5. Float and Redirect. Players who can predict the motion of the ambient balls often choose to click less, which uses less energy (yielding more points) and also avoids the possibility of clicking too close to a ball, imparting a greater than intended force and thus accelerating a ball to dangerous speeds.

6. Differentiation of Mass. Players who understand that the white and grey (heavier) balls need more force to move them (and stop them) will click more to get them going and will avoid their path.

These six strategies are common in the videos and appear to grow with the development of the player. These strategies were selected because of their prevalence in the videos and their importance in the explanations given by playtesters in the game. For example, we can observe in the Silverback videos that players exclaim: “I got to wait for them to clump together and a path to clear” or “they are all attracted to each other” as they predict where to safely move their ball. We have also observed other students explain that the blue ones (lower mass) are much harder to handle because they are so reactive to the impulse and that the white ones (higher mass) are harder to move out of the way. We can see in the video that players tap rapidly three times near a white ball when only tapping once near a blue ball. They are experiencing over and over again, and thus beginning to predict, that the white one has more inertia even if they would not use those words.

The videos from our playtesting also show evidence of emergent skills associated with physics learning that we did not anticipate during the design of the game, such as precursors to vector arithmetic. When players encounter a clump of balls between their ball and the goal, they will trace out a detour around the clump. We see through mouseovers that players often trace horizontal and vertical components to their paths, breaking their trajectory up into Cartesian coordinates. They are creating vectors in their mind and tracing them out on the screen for themselves, even though there is no prompt or tool to do this. When we saw exhibited by players who had not taken a formal physics class, we added it to our list of strategies to try to observe, thinking it might serve as the basis of an assessment on vector thinking, or a classroom lesson that a teacher might use.

Distilling Features for Detecting Strategic Moves in Click Data

While the video data allows us to observe and describe the strategic moves that players make during playtesting, these techniques are limited to the samples we can observe directly. To detect these cognitive strategies without video, our first step is to accurately identify their components parts—the strategic moves—from the game log data, discussed in detail below.

Once models are developed that can recognize strategic moves in the data, we can look for sequences of those moves as evidence of cognitive strategies players use to succeed in the game that we hypothesize reflect a tacit understanding of Newtonian motion. We can further mine the data to examine the sets of strategies that apply to players who advance farther or more rapidly in the game (expert players), using regression models to identify the combinations of strategies that are characteristic of greater and lesser degrees of advancement. We can also mine to see the evolution of a player’s strategy over time, using Bayesian Knowledge Tracing (Corbett & Anderson, 1995) to track the development and application of new strategies over time, and learnograms (Hershkovitz & Nachmias, 2008) to analyze the emergence and disappearance of strategies over time in a more qualitative fashion.

To obtain data that can be used to develop automated detectors these strategic moves, we will code a larger sample of videos from 70 players using the coding system described above. Those coded clicks will act as ‘ground truth’ against which the goodness of any predictive models is assessed. To build these models, we will distill sets of features from the raw features available directly from the log files (timestamp, locations of balls, clicks, and player, game level). The feature distillation process will explicitly select features thought by domain experts to be semantically relevant to the strategies observed by the human coders (Sao Pedro et al., 2012), and will be selected with consideration both of construct validity and feasibility for distillation. Distilled features will fall into three main categories. A non-exhaustive list of examples is given in Table 1.

Distilled Feature Type & Example		Rationale
Player Ball		
1	Distance between Player and Goal	Players use different strategies when close to the goal than when farther away
2	Current speed of player ball	If the player is moving faster they need to use different moves and strategies than when slow
3	Distance travelled since last event	This provides an indication of how much the game state will have changed
4	Change in angle between player's path and a straight-line path to goal	Strategies vary depending on whether or not player has a straight-line clear path to the goal
Impulses		
1	Proximity of impulse to player ball	Identifies the likely intended target (player ball or other) of the impulse.
2	Time since last impulse	Very quick actions may indicate panicking or intentional increased force; very slow actions may indicate floating strategies
3	Distance from impulse to closest other ball of each type	Identifies the likely intended target (player ball or other) of the impulse and identifies if players click more near certain color balls.
Other Particles		
1	Number of other balls in play space	Describes the potential complexity of the play space
2	Number of balls in path between player and goal	Describes difficulty of immediate task of getting to goal
3	Number of balls in current path of player ball	Describes immediate danger of collision

Table 1: Distilled feature types, examples, and rationale

Once the features have been distilled from the raw, educational data mining prediction methods (cf. Baker & Yacef, 2009) will be used to build models that automatically infer strategic moves. Classification algorithms that have been successful for similar problems will be tried (such as J48 decision trees, JRip decision rules, logistic and step regression, and K* instance-based classification), within the RapidMiner software (rapid-i.com). The resultant models will be assessed for predictive validity within data from new students, using cross-validation (Efron & Gong, 1983), where a model is repeatedly built using subsets of the data and tested using subsets.

The Challenges of this Emergent Approach to Game-Based Assessment

While not wanting to "break" the gameplay with any form of invasive assessments, and trying to measure knowledge that is tacit and may be unexpressed even within the learners' own minds, we create a challenging assessment task. Even as we gather evidence that illustrates cognitive strategies players use in the game and can show that they are replicated and predictable, we still have the challenge to say that this game progress demonstrates tacit understanding of physical phenomena represented in the game. A related question we return to repeatedly is whether we are measuring the player's learning of science or just becoming expert at the game mechanic. Assessment design has the perennial challenge of ensuring the logical coherence between the behaviors the task (here, the game) elicits the competencies it is designed to assess. In gameplay, the learning of the game may be confounded with learning of the subject matter of the game. This is not a new challenge in assessing learning within gameplay; even in games with known learning objectives, designed to support assessment of specific skills, it can be difficult to distinguish between domain learning and gameplay learning (cf. Baker, Habgood, Ainsworth, & Corbett, 2007).

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Interest in Citizen Science

Amanda Barany, Matthew Gaydos, Kurt Squire
University of Wisconsin-Madison

Abstract: Video games may be useful for improving student interest in pursuing STEM content areas. In order to explore their potential, reliable measures of interest must be developed that are appropriate to the game and that are theoretically motivated. This study presents pilot data of a survey that is being developed to measure interest associated with the game *Citizen Science*.

Video Games for Interest Development

Video games have been proposed as potentially useful tools for learning, especially in science, technology, engineering and mathematics domains (National Research Council, 2011). Specifically, games may be useful for getting students to engage with and learn complex scientific systems (Clark, D'Angelo, & Schleigh, 2011), to learn concepts more intuitively (Squire, Barnett, Grant, & Higginbotham, 2004), and to participate in scientific habits of mind (Duncan & Steinkuehler, 2009). Additionally, video games have been considered for their potential to deliver widespread, high-quality STEM education to American youth given their current popularity and distribution, as well as their tendency to use good learning principles (Mayo, 2009; Gee, 2003).

Given research suggesting that games can be powerful motivators for learning (e.g., Malone, 1985; Lepper & Cordova, 1990), and the close relationship between motivation and interest (Schiefele, 1991), the proposed use of video games to promote player's interest in science topics is plausible, though currently underdeveloped. Squire (2004; 2005) for example, documents examples of students' engagement with the game *Civilization* in a classroom setting, and suggests that good commercial video games can be used to pique students' interest in academic topics like history or geography. Squire however, does not define interest development in the context of *Civilization* with respect to definitions of interest presented in research literature (e.g., Hidi & Renninger, 2006). Though the compelling experiences that good video games provide for their players may help to develop student interest generally in related topics or activities, resulting in improved performance on related academic tasks (Steinkuehler, 2010), targeted development of topical interest is still relatively unexplored.

Defining and Measuring Interest

In order to determine whether and how games promote interest development, a definition and model of interest development must first be articulated. As defined by Hidi & Renninger (2006), interest is considered to be "the psychological state of engaging or the predisposition to re-engage with particular classes of objects, events, or ideas over time" (page 112). It can vary in depth and complexity and is defined by four phases: 1) triggered situational interest, in which the individual attends to learning content, yet requires outside influences to help sustain interest; 2) maintained situational interest, in which the individual recognizes the value of the content and engages with it for longer periods, yet still requires external supports; 3) emerging individual interest, in which the individual begins independently reengaging with the material; and 4) well-developed individual interest, in which the individual regularly engages with the material in more depth (Renninger & Su, 2011; Hidi & Renninger, 2006). Increasing student interest in science domains is important, as improved interest has been linked to improved measures of student performance. For example, when asked to connect science content that they learned in class to their personal lives, students who had low expectations of success in the course saw improvements, both in reported interest and in course grades (Hulleman & Harackiewicz, 2009).

The goal of this research was to begin the development of reliable measures of interest development in a video game context in order to inform existing theories of interest development and to improve on the design of the game intervention used. We envision evidence of player interest development in a video game context to eventually rely on sources typically used to study interest, including surveys, extra-curricular activities, interviews and observations. Additionally, because digital actions can be logged, we expect to coordinate in-game and related activity with these other sources of evidence to develop models of student interest development across contexts. Our first step in this process, however was simply to modify a survey that had previously been used reliably, so as to validate our own items and measure interest in topics related to our educational game, *Citizen Science*.

Methods

Citizen Science is an educational adventure game developed with the goal of teaching students about lake science and civic action especially regarding issues that currently affect Madison, WI. As players progress through the game, they interact with non-player characters (NPCs) and a simulation of Lake Mendota, collecting evidence and making arguments in order to convince the NPCs that they should act to improve the lake's health. As the player completes arguments, the narrative advances and new areas and arguments are unlocked. The game is over when the story and all nine arguments have been successfully completed.

In this study, 106 undergraduate students enrolled at large university in Midwestern United States played Citizen Science for approximately forty-five minutes in order to become acquainted with the content that the game addresses. After playing the game, players were asked to complete a seven point Likert-scale interest survey related to topics addressed through game-play and regarding the game itself. The survey was a thirty-one-item questionnaire designed to measure triggered situational interest in the session (an immediate interest response, or "catch") and maintained situational interest (situation-supported interest) related to civic participation, lake science, and video game play. Items were presented in a random order per subject.

Survey items were adapted from existing questions developed by Linnenbrink-Garcia et. al. (2010) that were developed to measure situational interest in academic settings. Since the original interest survey addressed psychology content taught in a classroom context, the questions were modified to instead assess player interest in lake ecology, citizen action (or activities that improve the health of local lakes), and video game play, both in classroom and non-classroom settings. Specifically, questions pertaining to classrooms or teachers were dropped, and question topics were altered to reflect game content. A question such as "I think the field of psychology is interesting," for example, would be changed to "I think the field of lake ecology is interesting" (see Table 1). Upon completion of data collection, six participants were removed from the dataset due to session irregularities (e.g., answering quickly and down a column), leaving an N of 100.

	Sample Question	Number of Questions
Lake Ecology	The information I learned about lake ecology is important.	9
Civic Action	I think learning about what I can do to improve the health of local lakes is interesting.	9
Educational Video Game Play	I am excited to learn through playing educational video games.	8
Recreational Video Game Play	In my opinion, playing video games is important as a leisure activity.	2
Citizen Science (the game itself)	I enjoyed playing Citizen Science.	3

Table 1: Survey Makeup and Example Questions

Results

Reliability statistics for each category to determine which items could be dropped for greater measurement reliability (see Table 2). Cronbach's Alphas for each survey section were above .8.

An exploratory factor analysis using maximum likelihood estimation for two to five factors and oblique (Promax) rotation was also performed. RMSEA was initially poor (.107) likely due to small sample size, and suggested two underlying factors related to either the content introduced in the game (i.e. lake ecology or civic action) or game play (i.e. educational, recreational, and Citizen Science). Three content items and four gaming items were removed due to similar loadings across both factors and wording. For example the content question, "I can apply what I learned about lake ecology to real life" was removed because in the one hour of game play allotted, participants may not have progressed far enough in-game to cover sufficient content regarding lake science that they could apply to their lives. Questions that were particular to Citizen Science were also removed, such as, "I enjoyed playing Citizen Science." These questions were likely capturing something like the situational interest of the game play experience, which in turn may have been affected by an interest in not offending the game's developer/researchers. Removing these items improved model fit from χ^2 = 865.110 (404) (p < .000) to χ^2 (481.610), p <.000. A modified version of the survey then, could include either 28 questions total or 15 questions that addressed in-game content (Appendix A).

Discussion and Conclusion

Substantially more work needs to be done if we are to take seriously the project of using games to measurably improve student interest in STEM disciplines. The study presented here was a pilot, and as such, includes many limitations. For example, the relatively short amount of time students were exposed to the game (approximately one hour), likely impacts the game's potential to develop more than triggered situational interest. Because interaction with the game was relatively short, any maintained situational interest captured by the survey will likely be minimal at best and individual interest is likely influencing survey responses, especially with respect to the educational content. Survey respondents (undergraduates) were also not the intended game audience (upper elementary school students) and items may need further modification depending on reading levels. Given the modifications to the survey that we made (i.e. the questions dropped), we suspect the items will be useful in addressing student interest in topics covered within the game, but developed outside of game play. Future use of survey results may be as covariates or pre-test measures that help to better characterize the player and the different interests that students bring to the table, which in turn may influence game play and learning outcomes.

Because interest in a content area often leads to a deeper understanding of the material, and can help shape future development, measuring the effectiveness of particular games in promoting interest is useful. Understanding how to measure the pathways of interest development can not only result in improving theories of interest development, but can also inform the design of educational software. Applying interest theories to educational video games raises at least two challenges, however. First, when used in conjunction with a course, the target domain for interest development may not be the only content included in the game. Video games, especially ones that are not designed specifically for the purpose of classroom use, often contain elements of fantasy and require their players to suspend their disbelief. Further, games include models, which are inherently inaccurate representations of reality. Players are required to interpret the content presented, and do so based on their inherently varied current social, political, and cultural positions (Devane & Squire, 2008). Because video games frequently focus on creating an enjoyable player experience they may purposefully simplify the educational material or embed it within a narrative so as to make the game more enjoyable or coherent. Measuring and tracking interest development in the context of non-content may be useful for advancing our understanding of interest development and for informing design modifications that could be made to the game.

Second, interest development is inherently complicated. It can develop along unexpected pathways that are not necessarily related to the immediate content or context (Disessa, 2000; Barron, 2006). When used in a curriculum context or for college students, *Citizen Science* may clearly relate to particular content, however, players may not follow up on their interests for many play sessions or may do so in other, difficult to track ways. The issue that this study raises is one of selecting an appropriate unit of analysis – if interest must be topic specific and games introduce multiple topics simultaneously, what topics are salient to players and does context matter? Given this challenge, a practice oriented model (Azevedo, 2011) rather than the four-phase model may be more useful, given that the four-phase model assumes that interest is relatively stable and topic-specific and a practice approach focuses more broadly on associated activities (e.g., gaming) rather than on content. Adopting a practice perspective, while potentially more accurate, requires rectifying a targeted interest development intervention with more naturalistic ways of playing, however and may not be appropriate for more formal learning environments.

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Games for Mindfulness and Pro-Social Behavior: The Tenacity Project Collaboration

Mike Beall, V. Elizabeth Owen, Allison Salmon, Stefan Slater, Amy Smith, Greg Vaughan,
& Constance Steinkuehler, Games+Learning+Society, constances@gmail.com
Reza Farajian, Lisa Flook, Abigail Freeman, Chris Harty, Tammi Kral, Daniel Levinson, Enrique Solis,
& Richard J. Davidson, Center for Investigating Healthy Minds, rjdavids@wisc.edu

Abstract: Educators have long been concerned with not only the development and transmission of knowledge in the classroom, but also in the social and moral development of children (c.f. Noddings, 2002). To this end, the Games+Learning+Society Center has joined in collaboration with the Center for Investigating Healthy Minds in a project called Tenacity. The work pivots around the development of two iPad games: *Tenacity*, a game cultivating the self-regulation of focused attention using breath counting; and *Crystals of Kaydor*, an RPG designed to cultivate the development of pro-social behavior through collaborative, cooperative and kind social interactions. Creating both of these games was a wonderfully rich collaborative process of connecting the practice of breath awareness & pro-social content to data-driven iterative game design. This paper provides an account of the cross-disciplinary work done in the Tenacity project to connect the power of attention, learning, and games.

Introduction

The Tenacity project is a collaboration between the Games+Learning+Society Center and the Center for Investigating Healthy Minds. With similar research interests around constructive cognition and social behavior (c.f. Steinkuehler 2006, 2008; Davidson 2003, 2012), Dr. Richard Davidson and Dr. Constance Steinkuehler led the effort to create two new videogames centered around the development of mindfulness and pro-social skills. The team engaged in iterative game design, ongoing collaboration, and frequent, early user testing, allowing for optimization of data-driven design practices throughout the project.

Tenacity's core focus was on developing and researching iPad-based tools to cultivate tenacity in 8th grade students to prepare them for high school and college success. The project supports the development of two specific games, each within a different skill domain. One game is intended to cultivate the self-regulation of attention and the other is intended to cultivate the development of pro-social behavior, particularly sensitivity to the non-verbal communication of others and skill at collaborative, cooperative and kind social interactions.

Games and Content

Mindfulness is based on the contemplative practice of breath counting. In *Tenacity*, the first game developed in the project, you practice awareness of the breath by being challenged to count a set number of breaths (five by default), again and again, for 5, 10, 15, or 20 minutes. As you play, you can choose from two different visual styles. In the first style, you casually follow a path through ancient Egypt or Ancient Greece**.** As you count your breaths, flowers will begin to grow along the path. In the second scene you can ascend into the heavens on a spiral stairway. Following the spiral stairway as it rises above the treetops, ducks and geese begin flying by. Rising higher and higher, the stairs ascend into the clouds and then into space where you can see the moon, spaceships and even other planets. As an additional motivator for accurate mindfulness practices, *Tenacity* also features an achievement system that rewards players for successfully counting their breaths without making errors, as well as resuming accurate counting after making an error.

Figure 1: Egyptian Ruins in the *Tenacity* mindfulness game

The second half of the Tenacity project is the role-playing game *Crystals of Kaydor*. The goal of *Crystals* is to support cooperative and kind social behaviors. In the game, this is primarily achieved through the interpretation and response to non-verbal emotional cues of other game characters (designed based on Ekman's facial action coding system, 2002).

In *Crystals*, the player controls a robot who has crash-landed on an alien planet. Consequently, many of its parts have been scattered across the landscape of the planet. In trying to recover the missing parts, the player encounters several different types of alien life (see Figure 4). These aliens display a range of emotions upon meeting the player, which he or she must then accurately identify (select the emotion from a number of different options) and calibrate (indicate when the emotion is high vs. low in intensity). If the player successfully accomplishes both of these tasks, they may receive quests from the alien to help them with subsequent missions. If the player is unsuccessful at either step, the alien becomes unresponsive, and the user must attempt to successfully complete both tasks again in order to receive the alien's mission. The interactions with these aliens are key to collecting all of the missing parts and returning your robot home.

Additionally, in order to progress further in the game, the player must find and destroy red crystals, which make the local flora and fauna angry and hostile. Destroying red crystals restores balance to the alien planet; gathering blue crystals powers the robot's ability to pacify aggressive animals in the environment.

Figure 2: Early level map in *Crystals of Kaydor*.

Data Collection

One advantage of working closely with game designers and programmers on a project is the ability to implement robust data tracking and collecting systems into the game itself. In the Tenacity project, this was accomplished through the use of the Assessment Data Aggregator for Gaming Environments, or ADAGE. ADAGE works through collecting clickstream data such as player input (button presses), character states (player attacked or low on energy), and cumulative experiences (overall game progression). These data can be used to identify patterns in play within and across players (using data mining and learning analytic techniques) as well as statistical methods for testing hypotheses that compare play to content models (cf. Loh, 2013; Halverson & Owen, in press). ADAGE processes can be integrated into any video game to allow for comparison of play across games and across learning environments (such as learning management systems or other forms of assessments). Design efforts like ADAGE model technology standards for transforming click-steam data into evidence for learning.

Both *Tenacity* and *Crystals of Kaydor* feature ADAGE integration, with a standardized set of data tags that capture a user's gameplay experience. The data tagging, or telemetry, system was tested extensively using groups of students attending the GLS Center or the Wisconsin Institutes for Discovery next door. An example of the telemetry system for *Tenacity* is below (see Figure 3).

Data-Driven Design

The use of ADAGE click-stream data is not limited to post-play analysis of player learning. Telemetry data acquired early on, and throughout the design process, was a vital component of user feedback and data-driven design. Jesse Schell, an iconic game designer, dedicates an entire chapter of *The Art of Game Design* to the maxim that "The Game Improves Through Iteration" (2008, p.75). Throughout the Tenacity project, player feedback and click-stream interaction data fueled informed, meaningful iterative design.

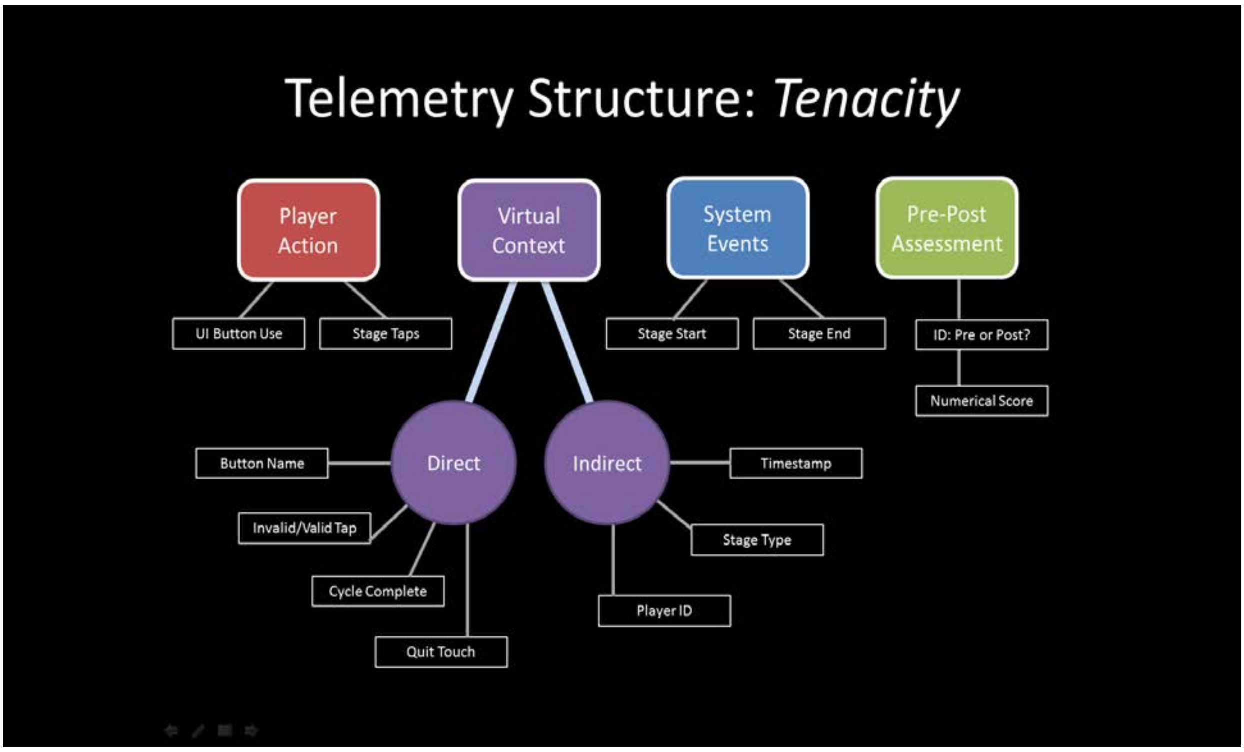

Figure 3: The structure of data tags in *Tenacity.*

One example of data-driven design centered on the non-hierarchical UI layout in *Crystals of Kaydor*. When a players first encounter an alien, they must correctly identify which emotion that alien is currently displaying. Initially, these emotion options were laid out in a 2 x 3 grid on the screen (see Figure 4). This layout was first tested with observation of user interaction, interviews with players about the matrix, and consultation with AI scholar and game designer Dr. Simon McCallum. Based on user interaction and feedback, development team members Mike Beall and Greg Vaughan set to streamlining the UI in a way that presented the choice buttons less hierarchically. The result was a radial design that served as a recurring motif in the game.

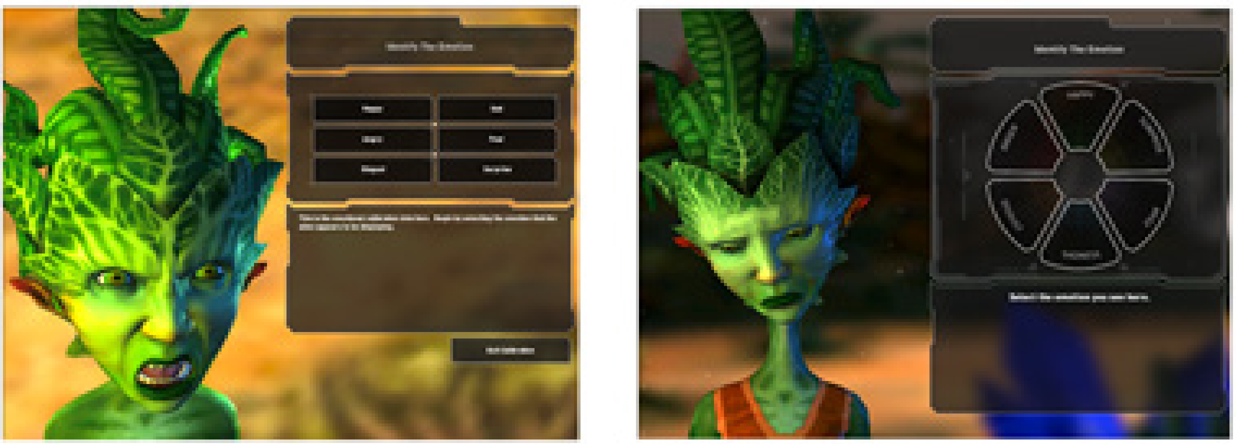

Figure 4: Emotion selection screen in *Crystals*. Left panel shows the first matrix version; the right panel shows the updated radial version.

Additionally, using data retrieved during play allows developers to tweak core game mechanics by using player feedback. For example, after selecting an emotion from the display, players then 'calibrate' that emotion using a slider. When the emotion is intense, players are instructed to move the slider up. When the emotion is not intense, players are instructed to move the slider down. A player who calibrates the emotion accurately enough can move on, but a player who does not must try again. However, for this mechanic to work, the game needs a "correct" calibration to compare player calibrations too. By having players play the game at playsquads and field trips, game developers were able to collect data on what player calibrations looked like and build a model off of those to use as the template for a "good" calibration. In this way, player calibrations were compared to those of their peers, instead of some pre-existing and pre-defined norm of what the emotion tends to look like.

Another interesting insight from early, frequent data collection involved player interaction with the pre-post self-evaluation meter in the *Tenacity* app. Some players rated themselves on extreme parts of the spectrum, while others remained perfectly in the middle. Too perfectly – at precisely .5000 out of 1, recurring consecutively. Thinking it was more than a coincidence that over half the players repeatedly shared this perfectly balanced score, we began to think about the mechanics involved. We hypothesized that players were, in fact, not moving the slider at all -- and just hitting the continue button to skip to the next session. Observations from the next playsquad corroborated this hunch. Informed by the data, we then implemented a mechanic that required movement of the slider before continuation of the game was possible.

A similar issue was found with the tutorial level in *Tenacity*. During playsquads, many students appeared confused and lost when attempting to use the *Tenacity* app, complaining that they didn't understand what to do, or how the app worked. We used ADAGE to confirm that many players skipped the tutorial level entirely in *Tenacity*, leading to their confusion. By making the tutorial level mandatory on a player's first play-through, this issue was resolved.

Similar patterns of map selection were also detected through early data analysis. Looking into a Markov-style progression of early play in the *Tenacity* app, we discovered that the majority of players were starting on one particular map (the Greek Ruins), when all maps were possible to play. We also discovered that if players did start the Stairway map, they tended to stay on that map rather than shift to a new one (Figure 5).

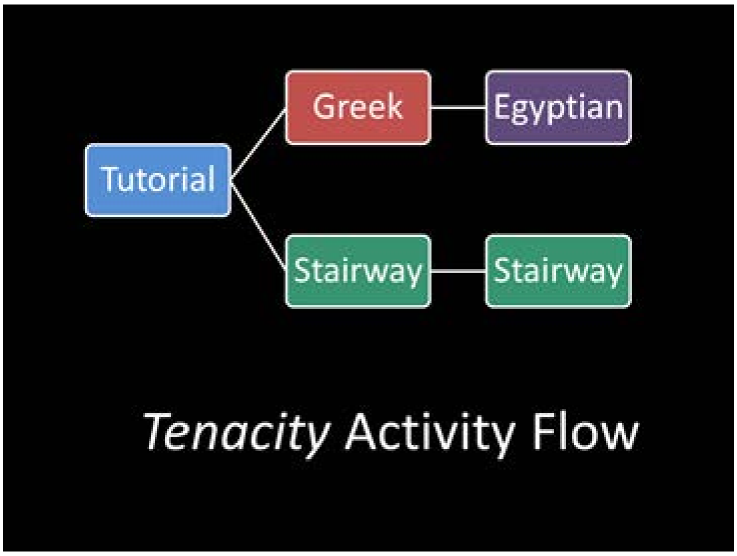

Figure 5: Activity flow for *Tenacity* level selection

We then set out to observe, in the next playsquad, why this particular pattern was happening. What we found was that there were two distinct groups in map choosing: those who figured out that there was a sidescrolling menu of map choices, and those who did not realize they had more options than the first one presented from left to right. Thus, this data led to a re-design of the map selection UI to display more of the maps at once, and in a matrix formation (rather than one horizontal sidescroll) (Figure 6).

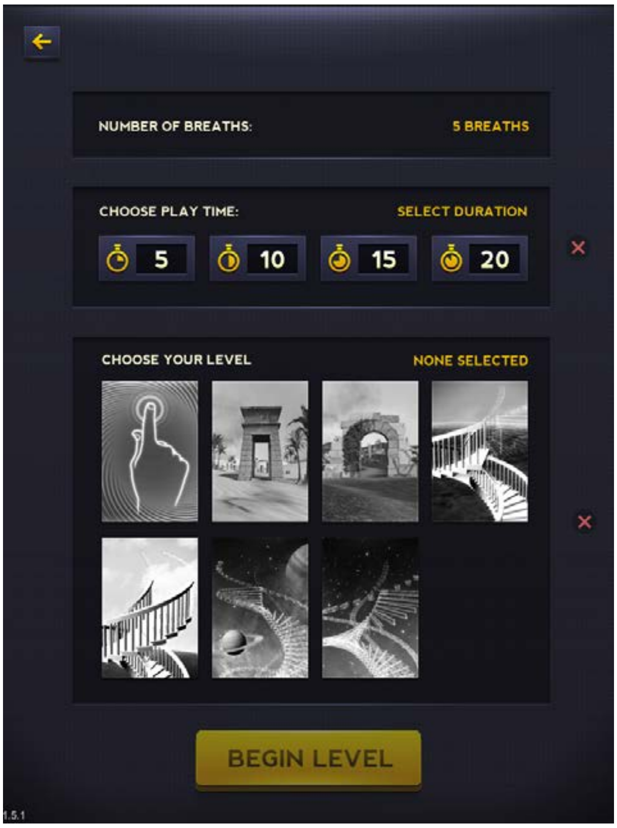

Figure 6: *Tenacity* map selection - final matrix design.

Conclusion

Overall, collaborative efforts with Dr. Steinkuehler and Dr. Davidson are supporting integrated research in the domains of digital media, learning, and neuroscience. In the successful building of the mindfulness and pro-social games, frequent team dialogue, ongoing playtesting, and data-driven design proved vital. Given extended support, we hope to build on this collaboration with future versions of *Tenacity* and *Crystals of Kaydor* for use with varying experimental design and research collaboration between GLS and CIHM.

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Meaningful Play: The Intersection of Videogames and Environmental Policy

Keari Bell-Gawne, University of Wisconsin at Madison, keari.lee@gmail.com

Abstract: Interactive multi-player simulation games have the potential to provide a more mature and statistically accurate approach to help better understand human behavior in relation to local environments and situated contexts. This could be used as a tool to better inform policy and research around environmental issues such as sustainability, food, and climate change. The Games Learning Society at the University of Wisconsin at Madison is currently working on an ecological simulation game, *Trails Forward.* In this game, three players: a lumber worker, a conservationist, and a housing developer, all work and compete within an accurate model of the Vilas county landscape. *Trails Forward* provides a template of how play in a simulated environment can inform our understandings of human behavior given real-world privileges and restrictions.

A Counterintuitive Model

The ominous threat of global warming, the seemingly irreconcilable tension between the environment and the economy, and the overwhelming immensity of environmental degradation leaves a solemn weight on many of us. In a time of such serious problems, video game play may seem the most counterintuitive savior. But maybe it isn't--in fact video game play may be the one of the things that *can* save us. Videogames can incorporate realistic multivariate simulations of locations, resources, and policy changes in a multiplayer environment. Instead of guessing how social research extrapolates to particular scenarios (such as the introduction of a renewable energy subsidy), video games allow us to preconceive the results of such policies over consecutive trials and foresee the quantitative effectiveness of such policies.

Gaming the system: The historical use of game based interaction to inform environmental policy

The idea of using games to inform environmental policy is not new. Following the advent of Nash's game theory in the 1950's (Nash 1950, 1951), experimental psychologists began reconstructing social dynamics via simplistic game models (Flood 1958; Edney and Harper 1978).

One of the most well known games is the Prisoner's Dilemma (also known as the Flood-Dresher experiment) (Flood 1958; Rapoport & Chammah 1965; Tucker 1983)[1]. This game was used to show that individuals may choose non-cooperation even if it goes against the collective best interest (including their own). In this game two subjects were asked to make a decision to cooperate or defect given a payment system similar to the one listed in table 1. While the actual game typically does not use incremental monetary values, it provides a way to quickly understand the game's dynamics. If both players are rational actors, they will always choose to defect. This is because if person A assumes person B will cooperate, their rational response will be to defect so to get $40 dollars instead of $30. If person A assumes person B will defect, then their rational action is to defect so to get $20 dollars instead of $10. Ironically, when both players act selfishly in their best interests, the total individual gain ($20) is less than that if they were to cooperate ($30). When this game was played with participants, the most likely response was for both participants to defect.

	Person B Coorperates	Person B Defects
Person A Coorperates	Each get $30	Person A gets $10 person B gets $40
Person A Defects	Person A gets $40 person B gets $10	Both get $20

Table 1: Framework of the Prisoner's Dilemma

The Prisoner's Dilemma is a commonly used to back up theories on environmental non-cooperation (Costanza 1987; Soroos 1994). Soroos (1994) argues that the Prisoner's Dilemma may play an important role in global climate change. With reductions to greenhouse gas emissions being perceived as antithetical to economic growth and well being, it may be that the seeming global apathy of climate change may be more indicative of mutual defection from cooperation than apathy of environmental issues. This may stem from a fear that if country A co-operates, country B may defect and gain economic and global power. Indeed during the Kyoto Protocol in 1995, many countries including the United States defensively pointed a finger at middle income countries like China that were considered Non-annex I countries and did not need to make immediate reductions to greenhouse gas emissions. The United States in particular used the 'unfair' growth of the Chinese economy under the 1995 Kyoto Protocol as reason to be the only non-signatory of the protocol (American Society of International Law 2001).

Furthering this understanding of non-cooperation, Hardin's paper, "Tragedy of the Commons" (1968) changed the way human interaction with the environment was viewed. The tragedy of the commons is an idea extrapolated from a simple scenario: If there is a common grazing pasture, some individuals will attempt to maximize their gains by putting more head of cattle on the common pasture than is sustainable. Further, although the benefits of putting extra head of cattle are only accrued onto some individuals, the costs are equally accrued onto all users of the commons. The instability of the short term gain is only realized when the poverty of the commons as a whole is realized, and the damage is often irreconcilable.

Once the idea of tragedy of the commons sprouted, several researchers set out to prove its existence and extrapolate on the idea through game based interactions. Edney and Harper (1978) had participants play a game in which players competed to get the most poker chips. The game was simple; every round the pile of community chips was replenished based on the end size of the pile. Every round, each member could chose to take one, two, or three chips from the pile. If all members overused the resource, the resource would eventually be unable to replenish itself, and the community as a whole would be left with less total chips than if all members only took one chip at a time. Moreover if one member took three, while the other took only one, the latter member would be making him or herself less likely to win against the player whom overused the pile. Edney and Harper found that players commonly overused the pile, and did not catch their mistake until it was too late and the resource could not replenish itself any longer.

Since the ideas of tragedy of the commons and the Prisoner's Dilemma, there have been tedious attempts to deconstruct exactly what variables reduce acting in self interest against the common good. Milinski, Semmann and Krambeck have argued that reputation can reduce the threat (2002), while Barclay (2003) explains it may be trustworthiness and competitive altruism. But perhaps the most influential bandage to our seeming Achilles' heel of short sighted indulgence is the influence of communication and large-scale regulatory systems (Cross & Guyer 1980; Hardin 1968). As a result, private husbandry of resources has been questioned, and the need for large scale regulation of common resources has become more popular (Costanza 1987).

While these games have undoubtedly been hugely informative, there is a simplicity to them that is a little unnerving. Several researchers have since set out to complicate the simplicity of these original experiments. (Axelrod 1980; Wu & Axelrod 1995; Boyd & Lorberbaum 1987; Faysse 2005). Some (Axelrod 1980; Wu & Axelrod 1995) have tried to better understand the mechanics by running them through computer simulations, others (Faysse 2005) have tried to make the games more realistic by allowing users to create their own rules. Still others (Lorberbaum 1987) have tackled the problem by finding contradictions in the proposed theoretical and evolutionary basis of the observed behaviors during the games.

While the tragedy of the commons, and the Prisoner's Dilemma have done an excellent job at increasing our understanding of human behavior in relation to shared resources, there are some serious flaws to drawing policy decisions from such simplistic models and moreover extrapolating these simple ideas into very complex policy.

While our understanding of physical processes, like ecological interactions and climate change modeling, have grown more sophisticated with technology, our understandings of *human* interaction with policy and the environment have continued to rely on understandings that are decades old. With the growing popularity of participatory policy making (O'Fallon & Dearry 2002; Hove 1999), some such as HENVINET (www.henvinet.eu) have tried to use technology to create meaningful participatory channels for activists to raise their voices in government (Grossberndt, Hazel & Bartonova 2012). While these novel uses of technology have been great for creating participatory networks for environmental activism, little technological innovations have been used to understand human interaction with policy and the environment *quantitatively.*

Videogames and the new era of quantitative resource modeling

At Games Learning Society at the University of Wisconsin-Madison, an ecological simulation game, *Trails Forward,* is being developed. This game may provide an introductory template to games based research that may help spur growth in the field, particularly in understanding human-environment interactions.

Trails Forward is a turn-based ecological multiplayer strategy game based in the Vilas county landscape. In this game, three players: a logger, a conservationist, and a housing developer, all work and compete within an accurate model of the Vilas county landscape. In this game players have sophisticated ways to enact their roles and use the land. For instance as a logger, the player has the ability to make several different kind of tree cuts (clear cut, diameter limit, and Q-ratio). Moreover all of the players have ways in which they can interact and benefit from each other. The logger can have the conservationist survey the land, and the housing developer can join a contract with the logger in order to utilize the cleared land for development. Finally, the map used in the game is taken directly from topographical data from the Vilas county landscape. That means the trees, water, and land, are all representative of the real landscape in Vilas county Wisconsin. The design for this game was created through the culmination of interviews with professionals in the field. For instance detailed interviews were conducted with the Department of Natural Resources and local loggers.

Figure 1: **Trails Forward Screenshot**

One of the major critiques of past experiments with traditional game theory is that it is hard to tell if the observed behavior from such experimental contexts can be considered valid. In other words, the controlled setting of these experiments may be too far removed from realistic settings to make any valid real world inferences from them. In *Trails Forward*, the environment is structured to support experimental control, but also has enough fluidity for human based interaction and change. *Trails Forward* provides a way to study traditional game theory within a more accurate and realistic context. As with traditional game theory experiments, *Trails Forward* provides a space in which players have competing interests, but can also benefit from cooperation. However, *Trails Forward* differs by providing accurate multivariate environments as its game space. Moreover, the roles for each player in *Trails Forward* were developed through rounds of in-depth interviews with the Department of Natural Resources and local workers. This was done to get an accurate depiction of the real-world restrictions and privileges of the represented roles, so to make the interaction of these roles in the game space as realistic as possible. Further, *Trails Forward* is situated within an accurate map of Vilas County in Wisconsin. Thus, It is situated, albeit virtually, within the actual geographical location of interest. As such, the results of observed behavior in the game space have more tangible extrapolations into real world.

What is perhaps most intriguing about using *Trails Forward* and other videogames for research, is that they have the capacity for effortless data extraction throughout the game play experience. One example of how such data could be used would be to look at resource consumption in trials pre and post policy implementation. The percentage of total resources can be tallied at the end of each cycle of game play (end resources/beginning resources) and then a confidence interval of percent resource use after game play can be gathered over several trials. In the case of *Trails Forward,* one could construct a confidence interval of resource use over a series of trials, and then compare that interval to one run when a new environmental policy is introduced to the players.

Furthermore, games like *Trails Forward* could be developed as templates where resources and land maps can be loaded into the game to examine the area of interest. For instance, instead of tree resources in Vila's County, a map the United States could be loaded with natural gas as the resource instead of trees.

To better understand if game play in *Trails Forward* provides reliable data, the distribution of end resources should be charted. If end resources fall within a relatively narrow confidence interval over a large series of trials (e.g. n=100), then it is more likely that as a research tool, *Trails Forward* is reliable. Moreover it would make it more likely that a significant difference in data pre and post policy would not be by chance.

To further the validity of research based games, a simulation of past environments (e.g. United States in 1972 before and after the introduction of the Clean Water Act) should be conducted. If such trials tend to repeat history with some accuracy, it is more likely that the claims we are making about the future are also valid.

Game based policy research is not perfect. *Trails Forward* is still a simulation, and as such the risks and consquences that happen in gameplay cannot compete with the immensity of real life consequences. However, games are unique in that they provide an immersive environment where participants feel compelled to react to risks and consequences, even if they are digital.

Moreover there is hopeful evidence that game based interactions, even when simplified, tend to follow past historical trends. One intriguing piece from Squire's (2011) extensive work with the game *Civilization III* in classroom settings is how history tended to repeat itself in gameplay (p. 27-28). In the game *Civilization*, players start at the beginning of human civilization and work to expand their civilization throughout the game. Each location has simplified but geographically accurate resources. Examples of resources include coal, horses, iron, and oil. Players can utilize resources and progress their civilization through investment in science, culture, technology etc. Given the distribution of resources along with the geography of the land, gameplay often re-enacts history. In many cases it is actually hard to play in a way that contradicts major components of history. For instance, the history of colonialism by European countries is hard to skirt. With access to horses, pan European-Asian trade networks, and population density, Europe commonly seeks to disperse its growing population into other colonies, and has the technological upper hand to do so. Germany particularly tends to be a violent nation due to its central location and outer population density, while India by contrast tends to be relatively peaceful (closed borders). While Civilization III is an extremely simplified version of the world, the realism of its variables often causes gameplay strategies and outcomes that align with history. Realizing that a commercial game has the capacity to give so much insight into our past is astounding. Civilization III has allowed children to understand history in ways that only some of the world's greatest thinkers used to understand. Technology and videogames in particular, have such potential to enrich human understandings of past and future phenomena, and to understand complex environment-human interactions. Perhaps, our greatest discoveries yet will come when we are able to glean the same insights about the future as we are able to from the past.

There is no doubt that we stand at the crux of many important decisions to come. Indeed, our generation may be one of the few with the chance to save the world. While sometimes it is easy to see all of the damage technology has wrought, there are such phenomenal innovations and abilities that technology can bring. Innovations that generations before us could never have fathomed. To think, if we can make children understand history in a way that samples the complexity of Karl Marx's genius just from playing a game, what possibilities might we encounter when we use these very tools to understand our future.

Let's play a game.

Endnotes

(1) The origins of the Prisoner's Dilemma are somewhat hard to track. The original experiment was done by Merrill Flood and Melvin Dresher through the RAND cooperation 1950 without formal publishing. Albert Tucker later worked to make the Prisoner's Dilemma more assessable to Stanford psychologists and is credited with coining the term 'Prisoner's Dilemma'. The idea spread without any formal published document, and so many of the citations sur-

rounding the Prisoner's Dilemma do not point back to a formal first publication.

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Game Guise: Analyzing Hierarchical Heterosexual Masculinity and Its Effects in Game Spaces

Keari Bell-Gawne, University of Wisconsin at Madison, keari.lee@gmail.com

Abstract: This paper seeks to discover how the use of heterosexual hierarchical masculinity as a tool for domination might affect younger players' abilities to learn in Team Fortress Two, and what implications these barriers to learning might have in school settings. Game interactions were observed using YouTube clips, noting in particular the use of satire and ostracism by older members against younger members as an attempt to eliminate younger players from the game space. Results indicated that older adolescents utilize heterosexual masculinity to ostracize younger players from the game space, often by feminizing the victim based on childlike appearances, and asserting their own heterosexuality and dominance by undermining the masculinity of younger players.

Massively multiplayer online games (MMOs) are online social spheres that contain rich culture and learning environments. Yet despite the massive quantities of players, as well as the relative ease with which this information could be observed, MMO environments are rarely analyzed for research purposes. Massively multiplayer online games have cultures that are usually expressive of, but not limited to, social norms outside the game context (Steinkuehler 2006). Kurt Squire (2011) explains in his book "Videogames and Learning" that "[game] play is deeply tied to gender identity, culture and social norms, and embracing play requires an awareness of these dynamics" (p. 171). That is, social spheres in game play are usually centered within everyday social norms and dynamics but in some cases, like in Team Fortress Two game play, parts of American culture such as masculinity, dominance, and heterosexuality, can be exacerbated. Thus, videogames are expressive of a microcosm of reality and sociality that can contain positive or negative social interactions, culminated and enacted in similar ways to spaces outside of the videogame context.

Two of these negative social interactions are prejudice and ostracism, and these can inhibit learning in a game space, just as it can in educational settings. Multiplayer videogames are a space in which learning and collaboration are integral to successful game play. James Paul Gee (2006) argues that videogames can be seen as a series of puzzles that the player must learn to unlock. Social games like Team Fortress Two tie this learning to social interaction. In order for players to learn the game, they must interact with the game, but more importantly they must interact and gain knowledge from the game community. In Team Fortress Two, players must collaborate to successfully accomplish a mission, and to protect and defend each other. Each player takes on a different role, such as a medic, or tank, and all players are interdependent. Members strategize about the best way to beat the opposing team, utilizing each member's individual talents and abilities. Each time a strategy fails, new ones must be constructed; this cycle repeats itself indefinitely, much like the scientific process.

In Team Fortress Two, if a player is ostracized away from social interaction, which is the foundation where strategizing occurs, it can hinder their learning and ultimately whether the player can play the game successfully. Ostracism can also hinder learning and game play by leading the member to drop out of the game space entirely. It might seem that in a utopian game space, all players would realize their interdependence and never ostracize other members, but there are times when the need for masculine dominance and hierarchy overrides this utopian ideal. Whether for reasons of self-esteem, in-group bias, or otherwise, in Team Fortress Two, hierarchical heterosexual masculinity is utilized as a tool for status and dominance to harass and ostracize younger players from the game space and can inhibit their learning and skill advancement in the game.

Masculinity in Videogames

Videogames are a type of media that have been traditionally created for males by males. Designers often recognize the demographic of "hardcore gamers" (typically "adolescent males") as their target audience, and therefore incorporate design aspects that are meant to appeal to this group (Fron, et al., 2007). Consequently, many videogames available today feature "highly stylized graphical violence," "male fantasies of power and domination," and "hyper-sexualized depictions of women" (Fron, et al., 2007). Since videogames have historically catered to a male oriented player base, the recent integration of women gamers has disturbed the social norms of video games spheres. Masculine and feminine social constructs are often defined antithetically, taking up opposite sides of the gender continuum. That is, masculinity and femininity are defined in opposition of each other, and their definitions only gain meaning once contrasted with each other. A male is what a female is not, and vice versa. For instance, Men are supposed to be “tough”, “strong”, “heterosexual”, and “dominant” and if they are not they are deemed “bitches”, “sissies”, “pussies”, and “faggots” (Katz 1999). With this construct, the recent introduction of females into gaming spheres may cause males to differentiate themselves by becoming hyper-masculine; furthering their behavior towards the extreme side of the masculine continuum in order to preserve their sense of masculinity. This antithetical view of gender clarifies why it is a direct insult to associate a man with a female, and it also clarifies why homosexuality, which is largely deemed feminine, is also typically rejected in this model. Moreover, a male player may be called a feminine name or associated with feminine characteristics, but it is unlikely that the name-caller truly suspects that the player is a woman. The sexual orientation of a fellow player, however, is more difficult to determine at face value than his gender, and therefore male players subject themselves and each other to constant scrutiny to determine whether they appear homosexual. Sanford and Madill (2011) explain this effect in their article “Resistance through Game play: It’s a Boy Thing”.

> Society has responded to expanded alternative gender positions with a rigid homophobic stance regarding masculinity. Young males today are faced with a fierce policing of traditional masculinity, and the rules of masculinity are enforced in many overt and subtle ways (p. 297).

Heterosexuality and masculinity tend to be synonymous in American society. Judith Butler describes masculinity as the penetration of females literally and metaphorically. She abstracts that the idea of masculinity involves an impenetrable facade. True masculinity (or more realistically, the masculine ideal) in this abstraction is impenetrable, and the penetration of masculinity with femininity is a “panic over being ‘like’ her, effeminized” (Butler, 1993). From this model, masculinity entails both the impenetrability of masculinity, such as emotional toughness, and the penetrability of females and femininity in general with the masculine. The domination of masculine over the feminine, or the penetration of such as Butler puts it, is a core construct of masculinity. This masculine penetration is often expressed quite literally by emphasizing heterosexual prowess.

The literal penetration of the feminine is often used as a construct to gauge masculinity and social status in an all-male group. Heterosexual masculine identity and sexual prowess is a construct which is sometimes used to sort male hierarchal structure (Kehily & Nayak, 1997). Consequently, this often means harassment and social ostracism for those at the bottom of the masculine hierarchy (Yee 2008), (Kehily & Nayak 1997). That is, boys gain status by testing one other and exposing who is more heterosexually experienced. This can take the form of using fictional heterosexual experience, real heterosexual experience, or can take the form of feminizing the victim into a subordinate less dominant female role (Sandford, Madill 2011). James Paul Gee (1999) explains that people us “Discourses” in order to be recognized a certain way. “Discourses” involve using the right social symbols, language, and tools at the right times. In the case of male gamers, whether the heterosexual experience is real or fictional is not of importance, so long as the stories are used in a way that makes them successfully recognized as heterosexually competent, masculine, and dominant. Often however, this “Discourse”, or way of acting, is called into question by other members, and used as a means of harassment. Erving Goffman (1955) called these identities and symbols of social interaction “faces”, and “losing face” is being publicly shamed because other members refuse to see the presented face, or deem one as not being worthy of that “face”. In male groups, “losing face” often takes the form of not being recognized as masculine. Active attempts are often made to make some members “lose face” by demasculinizing them. Demasculinizing the victim can be done through sexualizing the victim like a woman, or through implying the victim is homosexual. Returning to Butler’s (1993) theory of masculinity, the attacker is thereby penetrating the victim’s masculine facade and proving his own masculine dominance and penetration over the feminine (i.e. the victim).

Dominant heterosexual masculinity often emerges through satire that unites the dominant party, and ostracizes the target. Kehily and Nayak cite Lyman’s research, indicating the way in which sexist jokes consolidate the bonds of an ‘in-group’ through mutual hostility against an ‘out-group’” (p. 71). Robinson (1977) furthers this argument explaining that the function of humor is to “solidify the in-group, to attain gratification at the expense of another group…and there is a pecking order to the joke-telling. The joke teller is the dominant one; the joke is his weapon; his laughter is a sign of victory” (p. 67). This heterosexual masculine satire is used as a tool for advancement of status among young males in the Team Fortress Two (TF2) environment. Alexander (1984) outlines how jokes can be tactically used in his journal article “Ostracism and Indirect Reciprocity: The Reproductive Significance of Humor”

> C: Telling jokes on others is a way of
>
> 1. Elevating one’s own status;
> 2. Lowering the status of the butt of the joke;
> 3. Elevating the status of the listener by:

a. Allowing him to be in the right situation to laugh

b. Lowing the status of the object of ridicule;

4. Increasing camaraderie or unity by identifying the butt of the joke

(p. 118) [1]

Kehily and Nayak explain "our analysis suggests that humorous exchanges are constitutive of heterosexual masculine identities. We argue that humor is a technique utilized for the regulation of masculinities and the negotiation of gender sexual hierarchies within pupil cultures" (p. 69). These jokes are used to depress the victim's status and heighten the attacker's status. Further, these attacks increase in-group cohesiveness between some members, while harassing and deeming other males as out-group members. While this joke telling has positive consequences for in-group members, ostracized individuals tend to "feel sad and angry, and that they report lower levels of belonging, self-esteem, control, and meaningful existence" (Abrams, Hogg & Marques, 2005, p. 58), and "even a brief episode of ostracism by complete strangers is sufficient to cause pain and distress" (Williams, 2007, p. 236).

When the ostracism in Team Fortress Two (TF2) is put into context with games as learning devices, it can be seen as a tool used to inhibit learning and skill advancement in the game space. Games like TF2 are a series of puzzles and problems that often require social interaction to complete them. Steinkuehler (2006) explains:

> MMOG game play includes all of the traditional characteristics of problem solving—problem representation, conditions, goals, procedures, strategies, and meta-strategies—as well as shared practices typically found in problem-solving contexts within formal and informal instructional contexts—debriefings, theorizing about problem space, apprenticeship, and valuing of seeking out challenges just beyond the current level of one's ability (p. 99)

In these problem solving sequences, goals provide a finish line, but do not define the path to get there. Much like the goal of chess is to eliminate the other player's king, but the way to do so is open, the goal of videogames is often clearly defined, but the path to get there is not. Steinkuehler (2006) describes goals as well-defined problems. "Well-defined problems are problems that ostensibly have a clear initial state and goal state and with a tractable problem space between them" (p. 98-99). With this definition, games like Team Fortress Two have the characteristics of a well-defined problem. The game contains the initial state at the beginning of the round, and the end state is the team capturing the flag. The "tractable problem space between them" is the multiple strategies a team can use to reach their goal state. Moreover, TF2 pits two teams against each other for a *common* goal (much like capture the flag), and so the difficulty of the game increases as players learn more ways to get a leg up on each other. The two teams are forever co-evolving, as they learn to evade one another's tactics while strategizing new, more efficient tactics to enact themselves. Teams must constantly devise strategies and reconstruct them to optimize the likelihood of reaching a goal state. It is this strategy-building around which learning is centered.

The rejection of youth in these social spaces negatively affects their ability to learn how to effectively master the problem solving space, so to reach the goal state. If the youth are cut off from the player community, they no longer have access to debriefings, theorizing about problem space, or apprenticeship. In a game environment like TF2, It is essential for members to be socially accepted by their teammates in order to do well in the game.

In the game play studied, none of the rejected youth were allowed into any of the listed arenas of learning. They were not offered help by their older peers, nor were they regarded as a member of their peers' team. Anderson (1970) notes that for children in a classroom setting "It seems intuitively logical that pupils in classes where the teacher treats individuals in ways in which they perceive as inequitable, they will not learn as much" (p. 148). In the Team Fortress Two game space, youth were excluded from equal participation in game play, and were treated more poorly than other players. When the player is not socially included, they have no way to advance their skills. This is especially true in a social team-based game like TF2.

Methodology

This is a quasi-ethnographic exploratory study that uses qualitative methods to identify and analyze behaviors occurring in Team Fortress Two. Team Fortress Two is a first person shooter with cartoon like graphics and characters. All characters are highly skilled and customizable. Characters include "Scout", "Pyro", "Demoman", "Heavy", "Engineer", "Medic", "Sniper" and "Spy". Team Fortress Two is a massively multiplayer online game, that uses goal-oriented tasks (Such as capture the flag) to define its rounds. Most rounds pit teams against each other so that players must work together and utilize the unique skill set each character has. Players have the ability to talk to other players through the in game chat system or through microphones. For these data only transcripts of the microphone conversations were recorded.

Transcripts were taken of audio chat found on YouTube clips of TF2 game play. Three distinct YouTube clips were used that highlighted the use of dominant heterosexual masculinity. While these artifacts can sometimes be an exaggeration of the game culture, they are nonetheless representative of it. By exploring more conspicuous models of hierarchical heterosexual masculinity, like the YouTube clips chosen, a template beings to form that may evolve with future research to identify more subtle examples of hierarchical heterosexual masculinity in game settings, and other settings

Identification of players as youth was done mainly through voice recognition and identifying social interactions in the game space. Youth were often easily heard through their higher pitched voices. Moreover these youth were socially targeted for being young. Because of this, even if the players were not actually young is irrelevant, as the prejudice enacted is that against those that *seem* young. Moreover, while youth tended to be at the brunt of the struggle for heterosexual masculine identity, it was not necessary to be completely sure the youth identified were actually young, as the main dynamics involved were the social constructs and interactions, not the physical traits or characteristics of the players.

Team Fortress Two was chosen in particular because it seems to be a game with high tension between older and younger males.

Results

Hierarchical heterosexual masculinity was abundant in all three YouTube clips. In the first clip: "Team Fortress Two Annoying Kid" (gNatFreak 2009), this heterosexual masculinity took the form of sexualized mom jokes, and a lack of heterosexual sexual experience as reason for harassment. The younger male in this game first tries to assert dominance over an older male by using a traditional mother insults. He incessantly makes mom puns to an older male in the Team Fortress Two game space. Chris[1] goes from references of John's mom's vagina, to John's mom giving Chris a "bj" to doing "anal" on his mom. Sexualized mom insults might seem counteractive to a display of heterosexual masculinity since older mothers are often deemed less sexually attractive (save for fetishes), but Kehily and Nayak explain that "males are located as moral guardians of the sexual reputations of their mothers, girlfriends, and sisters" (p. 71). So sexualizing John's mother is a way to demean John's ability to protect his mother's sexual reputation. Alexander (1984) furthers this notion by explaining that jokes about sacred topics are often used to infer that the sacred topic is not important to anyone. Thus, Chris is implying that John's mother's chastity is not valued and is of little regard. John is demeaning Chris by implying that his mother has a bad reputation and that Chris is not "man" enough to defend her.

However, Chris's masculinity was contested right back. John attacks him saying "I can come up with the elaborate puns to make fun of you, like how I think your penis is so small so you have to compensate by saying you've had sex with 40-year-old women." By suggesting Chris has a small penis, John is making fun of Chris's ability to perform sexually as a heterosexual male. Thereby he is exerting his own dominance by suggesting that he has more heterosexual prowess and a bigger penis than Chris. John goes on "I just don't like it when [the game chat is] all about the sex puns from a little douche who's a virgin". Again John infers his superiority in a heterosexual masculine manner by implying that Chris is a virgin, and thus John is presumably more sexually experienced with women than Chris. These puns are directed at Chris's young age. Insults relating to the size of his penis and his potential status as a virgin are based on the assumption of his young age. His deemed inexperience with heterosexuality is also related to age, and ultimately it is this inexperience which is used to ostracize him from the game space. The bantering about heterosexual prowess continues throughout the clip, but the tactic remains the same: try to appear more sexually competent and thus more masculine by insulting the other player's sexual experience and masculinity. This is done until John completely socially dominates Chris. Chris finally leaves the game.

n clip two, titled "TF2-Kids These Days" (mygodthedingo 2008), dominating the younger player is done by deeming him sexually incompetent, along with feminizing him by sexualizing him. First Adam (the older player in this clip) demasculinizes Eric (the younger player) by saying "I bet you can't wait until you can masturbate". This pun infers lack of true masculinity because of his inability to perform sexually. This joke is targeted directly towards Eric's young age. The logic is, if you cannot ejaculate, you are not a real man. Eric defends himself and attacks Adam saying "what are you, like two?", but Adam furthers this logic and refutes by saying "but I can *cum*!"; A more literal expression of his ability to perform sexually.

Adam continues. He sexualizes Eric with feminine traits. This is a pun at Eric's age, inferring that his childlike features are feminine. After Adam says "I bet you can't wait until you can masturbate" he starts making groaning sounds as though he himself is masturbating. He tries to make Eric feel intimidated, saying "I'm watching you because I have your IP address and I can trace your house". Adam may be trying to make Eric feel vulnerable in a feminine way by subtly implying that he could go over and rape him. He furthers this notion of sexualizing Eric by saying “I’m looking at pictures of you; you’re well developed for an eight year old”. He starts describing Eric’s imaginary features sexually; he continues “he has short blonde hair, the brightest blue eyes…”. During this monologue Eric contests, emotionally upset, “Shutup!” he shouts. “I don’t have blonde hair you idiot, I have black hair! Freakin idiot!”. Eric likely feels harassed and unaccepted in the game community and is using whatever he can to defend himself. Adam feeds off it though, and he begins an elaborate display of his apparent orgasm from Eric’s photo. He screams and moans into the microphone and at the end he shouts “[Eric] just made me nut so hard, oh my god”. Right at the very end, before Eric logs off, Adam vulgarly says to Eric “Can I fuck your mom? Let me talk to your mother, I want to talk to that cunt”. Just like in the previous clip, Adam is trying to sexualize and demean Eric’s mother and ultimately Eric’s ability to defend his mother. This is the final straw before Eric logs out of the game space.

Throughout this clip Adam intentionally jokes at Eric’s supposed inability to ejaculate, feminizes him, and makes mom puns to exert his masculinity over Eric. By making fun of Eric’s ability to ejaculate, he highlights his own ability to do so, implying he is more masculine by being heterosexually competent. Male genitalia are clearly tied to masculinity, but an ability to use them in a heterosexual way (e.g. ability to ejaculate) is also essential to masculinity in this context. This is a direct insult to Eric’s age because it is insulting Eric for not going through puberty yet. Feminizing Eric in a vulnerable way serves two purposes: First to demasculinize him by feminizing him, and second to make him feel vulnerable like a woman by inferring he could rape him. Finally degrading Eric’s mother is used as an attempt to make Eric feel guilty and ashamed of his own inability to defend his mother’s image. All three attempts are congruent in that try to raise Adam’s apparent masculinity while lowering Eric’s.

Finally in the third clip “Homophobic Kid Gets Messed With” (Humantorch00 2008), the older male Paul uses a unique approach. Paul puts on an elaborate act; pretending as though he was flamboyantly homosexual, he “hits on” the younger male Andrew. With the constant rigid policing surrounding masculinity in Team Fortress Two, it is unacceptable to be the object of a “homosexual” person’s advances. There is no escape Andrew can take; Andrew is trapped. If he allows the advances to continue, he is feminizing himself and is seen as liking it, or even as homosexual himself. However if he violently contests the advances, as he does, Paul is quick to deem him has homophobic and thus probably homosexual himself. Paul starts “this kid is darling, he is just super duper darling (in an exaggerated voice)”. Paul may be using Andrew’s youth as a way to target him. It is implied he looks feminine and cute because of his age. He is also demeaning Andrew’s sense of masculinity by referring to him as “super duper darling”; a term of endearment for women. Andrew contests “Shut up! You’re gay!”, but Paul has the acceptance of the rest of the group, and he continues. Paul says “come on and give me a hug, give me a hug you little sweetie”. The other players, while still on Paul’s side, feel the need to exhibit their own masculinity at this point. One says “alright c’mon guys, too much man love”. As if listening to this homosexual banter is antithetical to their own show of heterosexual masculinity. Paul continues anyway. Andrew continues to violently contest Paul’s “advances”, and Paul responds saying “god damn you’re just a homophobe”. Andrew contests “no, no, no, I think you are because you are talking like a gay little girl!”. Andrew establishes a clear connection between acting homosexual and being a girl. He is trying to reclaim his masculinity by putting down Paul’s. Paul has him trapped though and uses Andrew’s apparent homophobia to his advantage. “It may be because of your homophobic issues. Because of your gay homophobic issues I think you’re secretly looovvvvinnggg this”. He makes the accusation that Andrew’s homophobia implies Andrew himself is a closeted homosexual.

Paul tries to make Andrew feel vulnerable by sexualizing him. He uses negative stereotypes of homosexuals as pedophilic sex offenders to his advantage. He says “sounds kinda kinky, grrrrrrr, I want you in my room”. Another player says “watch out he is underage” and Paul responds “that’s just how I like ‘em, grrrr”. He makes Andrew feel vulnerable in a feminized way by implying that he might sexually coerce him. By utilizing the role of a gay man, Paul successfully victimizes Andrew. He not only demeans Andrew’s masculinity, but victimizes him sexually. He successful exerts his own sexual dominance over Andrew while demeaning Andrew’s sense of masculinity by inferring that he is a closeted homosexual. In the context of heterosexual masculinity, inferring a boy or man (however blatantly false) is homosexual is a way to effeminize the victim. Revisiting Butler’s (1993) idea of the impenetrable masculine façade, Paul successfully penetrates Andrew’s masculine façade and credibility. Paul effeminizes Andrew by inferring he is a closeted homosexual, penetrating his masculinity with femininity. Further, Paul’s hint at homosexual rape implies a further, more literal, penetration of the masculine façade. Erving Goffman’s (1955) theory of “faces” of the self, that one tries to conform to the standards and expectations of a given social situation and to fail at doing so is “losing face”, can be used in this context. The young boys were forced to “lose face”. Their attempt at using the right social symbols, languages and tools, to create a certain “face” which was socially acceptable failed, (as the other members refused to recognize these “faces”) and they were run off by the older members. Goffman explains that “losing face” is one of the worst things someone could do to another, as extensive shame and threatened feelings result. Many of these adolescents after “losing face” logged out of the game space.

Discussion

While this study intends to examine hierarchical heterosexual masculinity and how it is used to ostracize youth from Team Fortress Two, it can also be used as a reference for school environments. TF2 is a game culture that is derived from social culture outside of the game space. Hierarchical heterosexual masculinity as a tool of dominance is used in school *and* game settings (Kehily, Nayak 1997). This research should be used to alert schools that behavior among young boys that seems like satire might really be harassment and discriminatory behavior (Robinson 1997), (Alexander 1984), (Kehily, Nayak 1997). It should be realized that heterosexual satire is not just used as camaraderie among boys, but also tends to be used with the intent of harassing and "out-group" member.

This research should also serve as a halt to blind positivism regarding "affinity spaces" (Gee 2006). Pushing towards the use of participatory culture and affinity spaces in school is a great leap in education reform, but it has to be noted that these learning environments may be just as prone to negative social ostracism as face-to-face interactions. It is nice to think of affinity spaces as an arena of true meritocracy, where many normal prejudices like age, sex, race and class go unnoticed, but the truth is that affinity spaces can be just as prone to prejudice as the outside world. During the observed game play, youth were ostracized for their inability to adhere to their peer's standards of masculinity. The affinity space of TF2 did not save them from being attacked for their age. The youth were not criticized for their skill in the game, as an affinity space would suggest, but rather for their inability to ejaculate, or their supposed homosexuality. The youth in the study were attacked in much the same way as they would be outside of the TF2 context, and indeed the TF2 context did little if nothing to shelter prejudice for identifying characteristics like age.

One possibility is that affinity spaces seem less prejudiced because there is not enough information about individual player's identities to develop prejudices and stereotypes against them. In TF2, it was likely the youths' young voice that clued older players to the boy's young age and opened the floodgates for discriminatory behavior against the young players. I would question whether the ability to know race, class, weight, or gender would have similar effects. Derogatory comments towards identifiable female gamers in male dominated game arenas like online first person shooters supports the idea that identifiable information may be used to against the victim. Future research should be conducted to understand how information about a player's social status such as race or gender might alter the way they are treated in a game space, as well as to what degree affinity spaces are more or less prejudiced arenas than the outside world. Future research might also try to understand how the demographics of the game space (such as young white males) might exacerbate some prejudices, while diminishing others. Gamespaces provide novel and interesting spaces in which to study culture. It is important to understand that the negative cultures, such as prejudice and ostracism, are not culminated independently in game spaces, but are rather representations of cultural models that exist outside the game space as well. It is a tactic too often seen, where videogames are pitted as the producers of such negative cultural characteristics. However, it is important to understand the ways in which videogames act as microcosms of reality, instead of producers of it. Because game spaces provide new ways of studying cultures, they also provide promising avenues for understanding how to negotiate negative cultures and culminate positive ones.

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The Role of Narrative in the Design of an Educational Game

Christopher C. Blakesley, The University of Wisconsin-Madison
The Jack Welch Management Institute at Strayer University
cblakes@gmail.com

Abstract: Storytelling is an important, engaging social practice. While video game designers are storytellers of the information age, educational video games fall short of using narrative effectively in practice. To better understand useful narrative approaches, this study explored how designers perceived and used narrative during the creation of an educational video game. A qualitative, ethnographic, single case study approach was used to collect and analyze data pertaining to the narrative design trajectory of the game design team as well as Citizen Science, the game artifact they produced. Findings include typologies comprised of fourteen key types of narrative perceptions and uses that surfaced in this case study. Implications include the notable use of narrative as a reward mechanism, and as a design team anchor.

Introduction to the problem

Video games with narrative stand to addresses critical educational needs. The Partnership for 21st Century Skills Learners posits that students need to be engaged with learning as they: “analyze and evaluate major alternative points of view” and “reflect critically on learning experiences and processes” (Trilling & Fadel, 2009, p. 52). There is a strong conviction that narrative can be designed to promote learning benefits through educational video games (Waraich, 2004). However, educational game designers fall short of using narrative effectively in practice. Although commercial video games lead the way in popular narrative game design, educational games stand as a unique genre that can make contributions that the commercial industry cannot (Squire, 2003). Educational game designers are positioned to innovate techniques that leverage game features uniquely to promote learning objectives. This constraint of meeting learning objectives puts designers into a unique situation where they are able to view and use features like narrative with innovation, experimentation, and distinction.

Narrative is an emotionally engaging feature of games as well as a primary mode of thought. Enhancing the quality of narratives of educational games for learning benefits is a compelling area of inquiry. To better promote the quality of narratives in and around educational games, it is important to investigate how designers utilize narrative during the process of production. The purpose of this study was to explore how designers *used* and *perceived* narrative during the process of designing an educational game, in order to identify and describe issues that can promote engagement for learning.

Literature Review

There are various narrative theories that exhibit relevance towards narrative design for educational games. Several narrative theories demonstrate views of narrative as it is expressed through types of media. It is also relevant to point out that the ideas presented here mainly pertain to *narrative as a research topic*, as opposed to *narrative research*, a methodology in which narrative provides the means of conducting research. This study distinguishes narrative using Äyrämö & Koskimaa’s (2010) three theoretical groupings of the concept. The first group, *traditional theories*, covers theories ranging from literature research to the beginning of French structuralistic narrative theory. The second group, often labeled narratology, is the *classical theory* category. Main ideas within this category include viewing narrative as a language, where a system of signs represent and contain certain meanings, such as signifier and signified, respectively (De Saussure, 1983). Thirdly, the *new theories* group has jettisoned the notion that narrative must be dependent on a medium for it’s existence, and embraces a more phenomenological approach. This study’s focus on narrative and knowledge aligns with this *new theories* group.

Cognitive psychology puts forth the idea that experience is mentally narrativized. We use our narrative-based mental models to predict future events. When those events violate our expectations, the result is meaningful learning and engagement. Jerome Bruner’s work extensively examines narrative as a scheme for making sense of experience. One of his primary and popular arguments is that there are two modes of thought: the paradigmatic and the narrative. The paradigmatic, or “logo-scientific,” way of thinking produces well-formed arguments, whereas the narrative way of thinking produces well-formed stories (Bruner, 1986). In alignment with Bruner, Schank & Abelson (1995) argue that virtually all knowledge is based on stories constructed around past experiences.

Much of the literature on narrative and knowledge places value on *surprise*, or *expectation violations* of some kind, where individuals’ predictions about what might happen in a given situation is undermined or changed by something unanticipated. This unpredictable change causes one to re-evaluate beliefs and assumptions previously held about the given context.

Within the literature on narrative and knowledge places value on surprise, or expectation violations of some kind, where individuals' predictions about what might happen in a given situation is undermined or changed by something unanticipated. This unpredictable change causes one to re-evaluate beliefs and assumptions previously held about the given context. According to Bruner and Schank, an important feature of narrative is surprise. The elements spoken of are strikingly similar to narrative design language for game creation. Players are assigned roles, goals, and obstacles as fundamental characteristics of many games. Expectation violation is a useful concept derived from cognitive psychology that is relevant to narrative design for educational games. While the question of how to leverage the benefits of narrative characteristics like these within educational games has been approached before (Äyrämö & Koskimaa, 2010; Dickey, 2006; Swan, 2008), the question of how educational game designers use narrative in practice has had relatively little attention.

Research Questions

The general narrative areas of character transformation, dramatic arc/interest curve, genre/surprise, and obstacle were selected to form a conceptual framework that guided this study during the pursuit of answering these questions:

1. *In what ways do designers use narrative during the process of making an educational game?*
2. *In what ways do designers perceive narrative as an attribute of educational games*?

Methodology

A single case study approach was selected to collect, analyze, and report the data. In order to understand narrative design for educational games, one software project undertaken by one professional design team was studied. A single case study was ideally suited for this specific study because of the highly contextualized and dynamic nature of software design collaborations and processes. This case was also selected because of the compelling narrative issues involved in the project, precipitated by choosing a narrative-based game genre (adventure games).

A single case study approach allowed the designers' specific practices to be explored within their specific contexts (Stake, 1995). The collection of numerous sources of data added depth to the research (Cresswell, 2007): interviews, observational field notes, design documents, and game artifact iterations. Analysis was done using triangulation methods to enhance validity (accuracy). Triangulation methods included the comparison of similar meanings derived from differing circumstances and data sources, such as design meetings, participant interviews, and playing the game artifact. Colleague researchers at a Midwest University also participated in reviewing segments of the collected data and providing interpretations that reinforced and called into question my interpretations. These reviews took place on campus at the Midwest University. Participants were also asked to member check, or review drafts of the researcher's written reports for accuracy and tone (Lincoln & Guba, 1985).

Findings

This study aimed to discover how designers use and perceive narrative during the process of creating an educational video game. This section gives an overview of the *Citizen Science* project, followed by a typology of designer uses, and a typology of designer perceptions. Between 2008 and 2012, a uniquely composed group of scholars and commercial designers began collaborating in a Midwest, U.S. city to produce a new kind of educational video game. The team spent four years carrying out design cycles in a process of iterative design to meet these goals. Challenges included temporal and budgetary constraints, as well as the merging of team members from the corporate and academic sectors. Two goals in particular drove the team's game design efforts: 1) centering the game upon identified learning goals, and 2) to make a game as fun as popular commercial video games.

As a narrative design process, the team's work followed a certain sequence of design focus. Attempting to encapsulate and represent the complex, cyclical nature of this design process is not an exact, comprehensive, or accurate endeavor. Nonetheless, by considering the projects' design process from a narrative point of view can shed light on one thread of progression through the design process (see Figure 1).

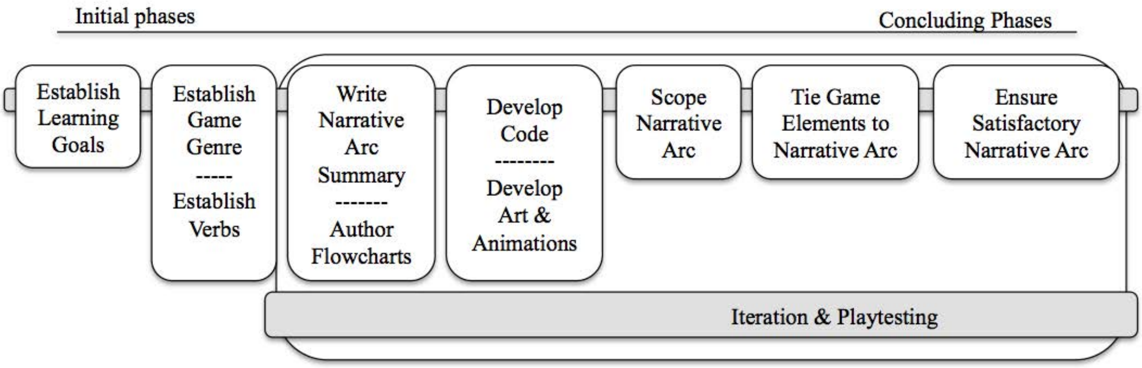

Figure 1: Narrative design process of Citizen Science

Citizen Science Game Summary

It is important to provide a summary of the *Citizen Science* game. This summary provides context for the reader, so as to understand what the player does during gameplay. Further, this summary is an example of one type of narrative perceived by team members. Frequently, team members would refer to an overarching narrative, in reference to the main plotline, or sequence of events that took place in the game. This summary is adapted upon participant Mike Boone's "extended summary" of the *Citizen Science* game:

> In this game, the player is a citizen-scientist who is tasked with the quest of helping to save a sick and potentially dying lake spirit – the fantastical representation of the once and future lake. The player explores the shores of Madison's Lake Mendota, first arguing with his/her father about letting their dog swim in the lake. The Lake Spirit proceeds to send the player back in time, to save the lake. Assisted by a friendly muskrat, and using a Lake Globe model, the player assists a limnologist, argues with protestors, and collects secchi disk readings.
>
> The player returns to the present, and is visited by the player's future self, who warns the lake is still not safe. With guidance from the limnologist, the player persuades farmers and fishermen to alter their behavior, and collects chemical readings that indicate lake runoff from farms. The player argues with some homeowners, convincing them to use proper fertilizer and plant rain gardens in their back yards, as it could help filter runoff into the lake.
>
> The player discovers that the once-friendly muskrat has turned antagonistic, persuading citizens to ruin the lake to benefit muskrat populations. The player convinces the muskrat to stop, in part by traveling to the Capital, to persuade a state representative to preserve local wetlands. Finally, the player saves the lake/lake spirit, but is visited by his/her future self, who invites the player to travel to the future, where more can be done to preserve the lake's health.

Uses & Perceptions

This study aimed to discover how designers use and perceive narrative during the process of creating an educational video game. While collecting data for this study, a central issue arose: designer uses and perceptions are frequently connected, influencing one another with reciprocity (see Figure 20). A designer making decisions would be making those decisions based on personal perceptions, and vice versa; ones' experience creating elements of a game would shape personal perceptions (see Alex Games' related notion of dialogues in Games, 2008). This reciprocity between categories challenged my decision to create categorical distinctions based on the research questions. Nonetheless, separating the two issues proved helpful for analysis, discussion and readability. I placed issues that were clearly demonstrated by Citizen Science designers, and that could be clearly implemented by future designers in the uses category. These are issues related to observable decisions made within design meetings or actions occurring through individual design work resulting in clear examples in the Citizen Science artifact. In contrast, I placed issues that were highly saturated with conceptual, abstract characteristics in the perceptions category. These are issues relating more to designer opinion, definitions, or grand debates than to demonstrable designer actions.

Figure 2: The reciprocal influence of narrative uses and perceptions.

Designer uses and perceptions of narrative

This study's first research question asked: in what ways did designers use narrative during the process of making an educational game? Seven issues were chosen because they relate to designer uses of narrative while creating *Citizen Science*. The issues pertain to observable behaviors made within design meetings or individual design work that is exemplified within the *Citizen Science* artifact. This study's second research question asked: in what ways did designers perceive narrative as an attribute of educational games? Seven issues were chosen based on data themes that were highly saturated with conceptual characteristics, designer opinions, and designer perspectives.

Designers used narrative to…	Designers perceived that narrative…
1. Establish a tripartite foundation 2. Approach work differently and similarly 3. Teach systemic relationships 4. Dialogue about design 5. Share a ludic affordance 6. Engage players through character transformations 7. Scaffold content and gameplay	1. Provided a flexible tool 2. Enabled good games 3. Emerged through gameplay 4. Promoted engaging gameplay 5. Encouraged positive identities 6. Engaged through fantasy 7. Provided a mechanism for reward

Table 1: Designer uses and perceptions of narrative

Discussion

This study presumes that by better understanding narrative design issues, future educational game design teams could refine and adopt effective narrative literacies, practices and processes that would enable engaging learning experiences through student gameplay and reflection. Designers could communicate with one another using deliberate narrative-related language in reference to the numerous types of narrative elements of games. Designers could be armed with narrative-related techniques and affordances specifically relevant to the *educational games* genre that would be usefully applied in design meetings and game production. Also, the team members specifically tasked with producing the narrative arc (e.g. the developer and writer) would be better positioned to embed narrative features that integrate engaging and pedagogical characteristics.

At the outset of this study, the general areas of character transformation, dramatic arc/interest curve, genre/surprise, and obstacle were selected to form a conceptual framework that guided this study during the pursuit of answering these questions:

In what ways do designers use narrative during the process of making an educational game?

1. *In what ways do designers perceive narrative as an attribute of educational games?*

While I discovered a variety of topics and issues during my data collection activities, this study's initial conceptual framework and research questions kept me grounded and aware of critical narrative issues as they surfaced. During this study's data analysis phase, several themes emerged, including the issue of fantasy as an engagement catalyst, the impact of genre design, the character turn as a prominent design technique, the prominence of the dramatic arc, and the challenge of leveraging emergent narrative.

I found several sophisticated instances of narrative use and perception among the designers of *Citizen Science*. Designers embedded narrative elements first and foremost in support of learning goals and in alignment with the selected game genre. They made decisions about setting, characters, and events to make the game as *good* as possible. Predominantly, designers perceived narrative as a *tool* used to impact the emotional engagement of players.

The implications of this study are based on a single case study. As Stake (1995) suggests, single case studies justify descriptive, rather than generalizable, findings. As such I convey implications by describing significant themes of this study – not to generalize but to indicate compelling issues that, when compared with future similar studies, have potential to become generalizable.

This study demonstrates the multifaceted nature of narrative. From the many narrative trends found in this study, two implications are highlighted: perceiving narrative as reward and the need for regularly reviewing narrative among a design team.

Narrative As Reward

Because designers perceive narrative as providing a mechanism for reward, we must reward players with natural narrative moments that generate uncertainty about content issues. The *Citizen Science* team valued narrative as long as it was naturally integrated with the game, and gave a sense of reward that would engage players towards sustained play. *Citizen Science* designers felt that "bad" narrative existed in games due to "slapping" it on without basing it's design on game themes, or using narrative events as mere transition pieces between game levels. In contrast, they felt "good" or natural narrative held attributes like being tied to learning goals and game mechanics, or engaging players to the point that they want to move the game forward with a sense of purpose and motivation.

As Frome and Smuts (2004) suggest, suspense is especially rewarding and impactful to the player during key moments of helplessness. These moments encourage reflection and consideration of fears or hopes about uncertain outcomes. For *Citizen Science*, there does not appear to be events that engage players emotionally to the extent described by Frome and Smuts, or desired by the designers. It seems fair to say a number of factors influenced this limited implementation: budget, time, prioritization of other design tasks. However, an aspect of the game that shows potential for instantiating such rewarding narrative instances are in the photograph macguffins (an object that drives a plot), where the avatar in the present and future are shown. These "Back to the Future" moments involved brightly colored photographs being displayed onscreen after a non-player character gave it to the avatar. The photographs served as a kind of lake quality window, allowing the player see a progress indicator as their arguments changed the quality of the lake over time. The lake would appear cleaner in the photograph as the player successfully argued with others.

These photograph-narrative events were connected to the learning goals because they conveyed the lake's quality to the player. The photographs also implied future, uncertain events to come – the futuristic picture shows a world that is unknown (the future), and as a non-player character states, the lake there is in more peril, which raises a question of what the problem might be, since the lake appears clean (non-eutrophic) in the photograph. These photograph moments show potential as rewarding narrative events because they propelled gameplay forward toward learning goal issues.

As I progressed through this research project, the issue of encouraging engagement and reward mechanisms often brought up potential criticisms or ethical debates around these ideas. A common theme of my discussions with participants was how narrative worked well in helping get players to want to keep playing. Narrative sometimes took on the image of emotional hits that designers doled out to keep players hooked on an experience. I reconcile these kinds of ideas with notions of balanced approaches to life being necessary and encouraged. I also felt that the incorporation of learning goals into the experience ennobled the efforts by designers to encourage sustained gameplay. In a culture that reveres the notion of lifelong learning, encouraging engaged curiosity is a worthwhile practice to encourage. Considering these criticisms brought me to the conviction that designers should make efforts to explore designing rewarding narrative moments that are imbued with uncertain content-related issues. The association between narrative-induced emotion and suspense around learning objectives is compelling.

Designers can ask themselves questions about narrative rewards to assist in the design process. Asking these questions can make a narrative event transform from a mere transition piece to a rewarding moment of reflection and suspense generation. Questions to ask include:

- *Does my game include narrative moments where the player is rendered temporarily helpless?*

- *Will these narrative moments make the player uncertain about a content-related issue?*

- *How can you encourage the player feel especially fearful or hopeful about their uncertainty at this point?*

Narrative as Design Team Anchor

Because designers use narrative to dialogue about design, we must encourage designers to regularly revise and review overarching narrative documents. *Citizen Science* designers engaged in design discussions that consistently depended on the established narrative for guidance. This deceivingly simple document has significant impact on a design team's ability to sustain a united vision and effectively make progress. The overarching narrative summary was one of the resources that was changed and rewritten often for the *Citizen Science* project. This is an obvious reason to continually share this document with the team – so that everyone is aware of changes.

The review of the overarching narrative summary should be a routine part of the agile software development cycle that many game design initiatives follow. The team should be in the habit of reviewing the summary, minimally, at the beginning of the iterative cycle. Because team members utilize narrative so often, the summary should be one of the items first considered for revision. If revising is needed, when it is done, the document should be made available to team members, to help them re-establish the perspective of the project.

Because this was a single case study, the findings can be generalized only if multiple case studies are replicated. Where educational video games are being created, a similar case study could be carried out by an outsider researcher or an insider – a designer on the team or member of the organization. With multiple case studies performed, methods of good practice around educational narrative game design could be identified.

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Composition and Computation: Integrated Learning via Video Games

Jim Brown, Becca Tarsa, Andrea Arpaci-Dusseau, Deidre Stuffer, University of Wisconsin-Madison
brownjr@wisc.edu, tarsa@wisc.edu, dusseau@cs.wisc.edu, stuffer@wisc.edu

Abstract: This Worked Example describes a three-course cluster offered during the 2012-13 academic year that uses video games to bridge the practices of written composition and computer programming. A group of 20 students enrolled in three courses—"Introduction to Computation," "Introduction to Composition," and a seminar course aimed at linking the concerns of the other two courses together—and spent the semester in an integrated learning environment that encouraged them to connect alphabetic writing with computer programming. By both analyzing and designing video games, these students were encouraged to see computational artifacts as expressive and rhetorical. This cluster will be offered again in the 2013-14 academic year. This Worked Example offers this course cluster as a way of using games to approach integrated learning projects, and it opens up a discussion about how to best use games in interdisciplinary teaching situations.

Introduction: Using Games to Study Composition and Computation

The idea for our example was to build a set of three integrated courses that give students the opportunity to work on writing skills alongside computer programming skills and to do so by having them create and critique video games (1). We carried out this experiment at the University of Wisconsin-Madison during the 2012-2013 academic year with an integrated cluster of three courses. The University offers a program for instructors who want to design such integrated learning communities, and the program is designed to help first-year students to transition into college life. Small groups of students (usually about 20) enroll in a three-course cluster that is organized around a common theme. One of the courses is a seminar that encourages students to see the interdisciplinary links between their work in the other two courses. In our cluster, students enrolled in "Introduction to Composition," "Introduction to Computation," and the seminar class (which was taught by both an instructor of record and a teaching assistant)

The idea of our cluster was to help students to see computer programming as a writing practice and traditional writing as a procedural (or even computational) enterprise. By exploring the links between both of these practices, we hoped to cultivate a sense of computational thinking that students could take beyond the classroom. Students were encouraged to understand traditional literacy practices alongside procedural literacy practices in a manner that emphasized the conceptual relationship between the two. By doing so, we hope to deepen students' awareness of computational and procedural forms as compositional and rhetorical practices.

Video games were one of the primary forms through which students explored these ideas and concepts. While students created various types of texts and computational artifacts, their primary projects in the seminar course involved the creation of video games that used what Ian Bogost (2010) calls procedural rhetoric, the use of computational processes in the interest of persuasion. Students created various games in "Introduction to Computation," wrote documentation for games and used other multimodal technologies to explain games in their "Introduction to Composition" class, and both critiqued and created video games in the seminar course. For instance, in the seminar they played games such as Molleindustria's *The McDonald's Game* and mtvU's *Darfur is Dying*, games that use computational procedures to make political arguments. Students analyzed how these games made arguments and then made their own games. Student games were inspired by Hal Ableson, Ken Ledeen, and Harry Lewis's *Blown to Bits* (2008), a book that they read in each of the three courses. By both writing and coding arguments inspired by *Blown to Bits*, students used all three courses to explore how games and other digital media open up different possibilities for communication and persuasion (2).

Inspirations and Motivations

This project takes much of its inspiration from recent explorations, in both composition and rhetoric and computer science, of the conceptual, creative and rhetorical similarities between programming and writing. Scholars such as Stuart Selber (2004), Andrea diSessa (2001), Bogost, Jeannette Wing (2006), and Cathy Davidson (2012) increasingly advocate movement towards an integrated pedagogy that diminishes the conceptual divide between writing a program and writing a paper.

Our central goal was to use analysis and creation of video games as an effective and engaging anchor for integrated learning, and we also had the additional goal, for this first iteration, of determining whether or not it was worth repeating – and, if so, what areas to focus the most energy on revising before next fall. We also hoped to get some insight into the best way to promote the cluster to students and administrators.

In addition to these underlying inspirations, all four instructors were inspired to participate in the project by research and pedagogical questions we've been mulling over individually in some form or another.

Jim Brown - Seminar Instructor: My research interests are in new media studies and software studies, and I am interested in giving students in humanities classes the opportunity to explore the rhetorical and literary possibilities of computation. I designed this cluster with the hopes that students could use my seminar to analyze and create computational artifacts that were not necessarily tools but were rather expressive artifacts. Video games were a particularly useful way to take up this work, and students in the course sought out ways to understand how their work in computer programming and composition classes could be combined in the interest of using computation to communicate and persuade.

Deidre Stuffer - Seminar TA: As a literature Ph.D. student I never imagined that I would be a technical presence in any classroom, but as the "Writing and Coding" TA I had to be the programming expert. In the end, the cluster was a good fit for my research interests. In my seminar papers I had been considering how technology mediates the writing process, reflected at the level of syntax and form. My experience with HTML and Java coding often prompted me to consider how digital objects challenge the metaphors through which we perceive the world. "Writing and Coding" allowed me to watch the students grapple with writing code and compositions as embodied acts. Furthermore, it broadened my horizons to the rhetorical possibilities of new media. I hope to teach the composition course in next year's version of this cluster, where perhaps I will catch glimpses of how contact with computational logic can alter student writing.

Andrea Arpaci-Dusseau - "Introduction to Computation" Instructor: As a faculty member in Computer Sciences, I am interested in teaching a wide variety of students about the importance of computation in everyone's lives. My goals in developing "Introduction to Computation" were to create a course that appeals to both CS majors and non-majors; as such, the course focuses on the big ideas of CS (e.g., creativity, abstraction, data, algorithms, and systems) instead of solely programming. Students use Scratch for programming, and thus learn about traditional programming concepts while creating motivating projects in a non-intimidating programming environment. For the programming projects, students experimented with randomized art, interactive stories, educational games, music composition, and basic data processing, in addition to a larger more open-ended project of their own choosing.

Becca Tarsa - "Introduction to Composition" Instructor: Since taking my first course in digital composition, my primary research interest has been adapting composition instruction - particularly freshman English - to best prepare students for the rapidly changing landscape of contemporary writing. The cluster's use of video games as a link between traditional composition practices and those of coding struck me as a great way to spread the work of integrating digital and traditional writing across multiple courses. I loved the idea that students could talk about games in the seminar, write about them with me, and build their own in their computer science course, and I'd still have time to prepare them for the traditional college essays they'll inevitably face before graduating.

Questions Asked by this Pedagogical Experiment

Our cluster of courses attempted to address a number of questions about writing and programming pedagogy and about how games can be used to bridge these two activities. We list those questions here in the interest of opening up a discussion about our worked example. This list is not exhaustive, and we aim to invite other GLS scholars to add more to this list.

- How can games be used as a bridge between computational and written literacies?
- How do we go about making useful connections between coded and written composition?
- How can we help students use written composition practices and assignments to deepen their procedural and computational literacy and vice versa?
- What kinds of assignments, cross-course collaborations, class formats, etc, best promote the goals of an integrated learning environment?
- And from a pragmatic standpoint: What should we be teaching these students, most of whom hope to

- enter computer science-related fields, to best prepare them for success in both their college and professional careers?

Scaffolding the Course Cluster

In the weeks leading up to this fall 2012 course cluster, the instructors discussed plans for each course both via email and in person. This gave us a sense of each other's individual plans for meeting the cluster's objectives, as well as general sense of the goals unique to each class. This helped us build a picture, as the semester progressed, of where the activities in our own classrooms overlapped with or built on those of the other two. One of the most tangible results of this front-end collaboration was the decision to use *Blown to Bits* as a common text across the three classes.

The text was already slated for use in the "Introduction to Computation" class, and Becca and Jim decided to integrate the text into their classes as well. This kind of collaboration is one important advantage of the course cluster format, which encourages collaborative course design. While each course incorporated other texts as well, *Blown to Bits* served as a touchstone across all three courses. The book fit well into all three courses since it explores the cultural implications of computation, and all four of us were excited about using it. We reasoned that having a shared text would help students to conceptually integrate their work across the three courses

Based on these collaborative preparations, Becca and Jim created syllabi aimed at speaking to the cluster's objectives while also meeting the goals of the individual course. (Not expecting to be part of the project until the last weeks of summer, Andrea had already finished her syllabus for "Introduction to Computation.") The Composition course used the 3-sequence model required by the University's first-year writing program by incorporating readings and assignments that connected the objectives of each sequence - reflection, research synthesis, and argument - to computational literacy as well as alphabetical literacy. Rather than writing traditional literacy narratives, for example, students were asked to reflect on the ways in which interaction with digital objects and environments has shaped their view of literacy. Becca designed a syllabus with the idea that a major game design project would serve as the central way for students to link their work in the other two courses.

Throughout the semester, students used the Scratch programming language to build a game that made a procedural argument about one of the chapters in *Blown to Bits*. Students worked in groups to build these games. They ran user tests, released multiple versions, and incorporated Picoboards (sensorboards designed for use with Scratch) to explore how games could be extended by way of physical computing. This semester-long group game design project served as the primary work of the course. Deidre prepared for her role by learning Scratch, the programming language students used for most of their coding assignments in both "Introduction to Computation" and the seminar. She designed a game of her own (*Bit Breaker*, a game that makes an argument about the persistence of digital information and issues of privacy) as an example. By coding, revising, and then presenting her game, Deidre showed students some of the possibilities of the Scratch platform.

Lessons Learned

We have completed one semester of this cluster, and it is again slated to be offered in 2013-2014. We are still awaiting course evaluations, and we hope to draw from these as we revise the courses for next year. While some of the instructors in this cluster will change, we do hope to carry over much of what we learned into the next version of the course.

This course cluster provided us with an opportunity to learn the advantages of integrated course design, and we learned that (with fairly minimal coordination) course clusters like this can be extremely effective at showing students that learning is not a siloed activity. Further, we learned that video games can be a particularly useful medium for exploring the links between different media literacies. While we faced the challenges that any educator using games challenges (for instance, students professing no interest in games or imagining that games are primarily for "fun" and are not "serious" academic work), we believe that the cluster's focus on both analyzing and producing games presented a convincing argument to students that games are a complex, rhetorically expressive medium.

In future iterations, we may use the seminar to have more theoretical conversations about the links between video games, composition, computation. While the seminar did provide some space for these discussions by examining Daniel Hillis' book *The Pattern on the Stone* (1999), the seminar was primarily focused on the video game design project. While we will not drop this focus on production (since it is so crucial for students to see the links between traditional writing and computer programming), the seminar might benefit from more balance between the theoretical and practical concerns of writing and coding. One way forward in this regard would be a focus on the burgeoning field of software studies, which uses the tools of humanistic analysis to examine software, video games, and digital fictions. One text that we will consider incorporating is the recently published *10 PRINT CHR$(205.5+RND(1)); : GOTO 10* (Montfort et al., 2012), a collaboratively authored book that examines a single line of code and "uses it as a lens through which to consider the phenomenon of creative computing and the way computer programs exist in culture" ("10 PRINT Website," n.d.). A text like this one would offer a specific example and would open up more questions about how computation and game design are threaded through culture and history.

Unexpected Challenges

As mentioned briefly above, we ran into the expected challenge of answering student resistance to the idea of video games as a meaningful and worthwhile learning focus. While many students (particularly those who were already avid gamers as well as aspiring CS majors) were an easy sell in this regard, those without preexisting interest in gaming or in computer science as a major were skeptical; this made it harder to engage them in the kind of integrated conceptual thinking about their work we wanted to foster.

It was also challenging to integrate assignments and course calendars across the three classes as fully and effectively as we'd initially imagined. While the time spent discussing and planning together before the semester began did facilitate some productive crossover between the courses, more in-depth coordination between course assignments proved more difficult than expected. For example, Becca had originally planned to have students produce documentation and other written support materials for the games they'd designed in the seminar class as their final project; however, the need to cover all the elements required by the first-year writing program made this logistically impossible to fit into the time remaining. An integrated project definitely seems feasible for future iterations of the course, but will require a bit more advance planning to make sure that it can be fit in around the program objectives, or designed to complement them as well as those of the cluster.

Assessing the Experiment and Soliciting Feedback

It can be tough to measure the success of long-term goals such as professional readiness and academic success without waiting a few years and tracking students down to follow up; obviously we won't be able to do that for some time, and realistically maybe not ever.

That said, there are still some useful measures of how we're doing. Most straightforwardly, if the cluster becomes an annual offering, as is our hope, enrollment statistics will also help us judge how things are going by showing us not only how many students are interested, but also who. Student evaluations are also a valuable tool here, especially with some effort on instructors' parts to encourage honest, reflective feedback. Further, the University program that sponsored this effort conducts their own assessment and shares it with instructors.

Just as important (if not more so) is how students perform within the courses - the quality of their work, their growth across the semester, the evidence in their discussions and projects of the kind of conceptual integration we're trying for. In the future, we hope to build some concrete ways of assessing this effort by way of qualitative and quantitative analysis.

Though there is always room for further improvement, there were definite signs of success in fostering integrated thinking about writing and coding, and about the links between computational and traditional literacy. In the composition class, well over half the students chose to pursue research topics related to concepts and topics they'd encountered in the other two courses. Many of these papers used video games as the focus through which to explore the concepts in question, suggesting that the course cluster's attempts to use games as a bridge between computing and writing were in fact successful. Students also frequently cited work from their other classes in the portfolios they compiled for their seminar class – further evidence that they'd begun to think about both written and coded work as forms of composition. On a simpler level, by the end of the semester students seemed very comfortable viewing all three classes as integrated learning experiences; references to readings or discussions from the other classes became increasingly common in all classes, and Jim even made a cameo appearance in several student projects for the other two courses.

The cluster was also a success in producing some excellent and interesting student work. Becca observed greater growth than is typical across student writing and overall performance throughout the semester, particularly in oral communication – students' end-of-semester presentations were exceptionally high quality, and delivered very comfortably and effectively. Student video games developed in both the "Introduction to Computation" course and the seminar were complex computational artifacts that used programming to make interesting political arguments about Internet privacy, data encryption, and copyright laws. This type of work likely stemmed more from the increased sense of community created by having three classes together (two of them seminars) than the course cluster's objectives; however, it supports the idea of clustered courses as an effective and beneficial means through which to pursue those objectives.

While we are pleased with the first iteration of our Worked Example, we know that there are more avenues to explore. Through continued assessment and a dialogue with other scholars working at the intersection of game studies and pedagogy, we hope to continue to revise and improve this course cluster.

Endnotes

(1) The format for this Worked Example is loosely based on the Working Examples website (http://workingexamples.org/). We have used the questions on that site to guide our discussion, and we see this example as being in the "sprout" stage, given that we will be repeating the course cluster during the 2013-14 academic year.

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Assessing the Common Core State Standards in Reading With *The Sports Network 2*

Jane Canner, Mary Schearer, Nicole Guagliardi, Classroom, Inc.
jcanner@classroominc.org, mschearer@classroominc.org, nguagliardi@classroominc.org

Abstract: Classroom, Inc. (CI) developed and piloted an 8th grade learning game targeting the Common Core State Standards (CCSS) in Reading. CI built on 20 years experience using workplace simulations to teach literacy, and developed *The Sports Network 2 (TSN-2)*, leveraging advances in gaming and assessment. *TSN-2* puts students in the role of managing director of a sports media company, giving them reading and workplace problems to solve. Piloted in 2012 with over 400 New York City and Chicago students and their teachers, teachers agreed that the game was strongly connected to the CCSS, and students reported being engaged and learning from it. Assessments on the CCSS from within the game showed modest student performance; scores were strongly correlated with scores from a standardized reading test, the *Measures of Academic Progress.* This research provides early validation for an approach within a game to assess reading skills based on CCSS.

Introduction

Classroom, Inc. (CI), a nonprofit educational organization that has used virtual workplace simulations to improve adolescents' literacy, critical thinking and career readiness skills for over 20 years, has served over 700,000 students and 10,000 teachers across the country. CI's digital literacy programs in public, charter, and parochial schools are most often used in middle and high school summer and after school programs, and in classes that include a substantial number of struggling readers.

In 2011, a Next Generation Learning Challenges (NGLC) grant enabled CI to develop and pilot a prototype for a new program that would leverage advances in game technology, real-time progress reporting, and differentiated learning pathways to help low-achieving 8th graders master the rigorous new Common Core State Standards (CCSS) in Reading, while connecting them to the world of work.

This paper briefly describes the game, its reading demands, and the pilot; and provides preliminary validity data on *TSN-2* as a reading measure. Because most digital learning games are now focused on math and science rather than reading (Schwartz, 2013), this work is significant in showing the potential for developing games to address the complex reading demands of the new CCSS in actual classrooms.

The Game

Games have the potential to be "good assessment engines" (Shaffer & Gee, 2012) and to link standards, instruction, and assessment (Phillips & Popovic, 2012; Shute, 2011), but games that actually do this, particularly for the new CCSS, in ways that schools can use are few and far between. CI's challenge was to develop and pilot test an engaging game for adolescents that could both help improve struggling students' CCSS-related reading performance in school, and provide valid assessment information.

The program developed, *The Sports Network 2*, is a simulation that puts students in the role of managing director of a sports media company and presents them with a rich array of reading and workplace experiences. The game takes about 20 class periods to play—15 online and 5 offline. The continuous narrative includes five game quests, each representing a "day at work". The game addresses the following four Grade 8 Common Core State Standards (CCSS) for reading informational text:

Key Ideas and Details

- RI.8.1. Cite the textual evidence that most strongly supports an analysis of what the text says explicitly as well as inferences drawn from the text.
- RI.8.2. Determine a central idea of a text and analyze its development over the course of the text, including its relationship to supporting ideas; provide an objective summary of the text.
- RI.8.3. Analyze how a text makes connections among and distinctions between individuals, ideas, or events (e.g., through comparisons, analogies, or categories).

Craft and Structure

- RI.8.4. Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze the impact of specific word choices on meaning and tone, including analogies or allusions to other texts.

At the outset, students learn that TSN-2 is swiftly losing its teen audience; the managing director must find a way to draw large numbers of teens to TSN-2 quickly. All five quests lead to that objective. This is a high-stakes proposition because people's jobs hang in the balance. The five quests are:

How Do We Draw Teens Back to TSN-2? Solve TSN-2's dwindling teen viewership problem.

What Is Our Audience? What Is Our Topic? Determine exact target audience and topic for new TSN-2 program aimed at teens.

What Sport Should Our Pilot Feature? Scout locations/choose a setting for "Teens & City Sports."

How Can We Pitch Our Pilot? Gather information, interview site coordinator, and create a storyboard for a pilot of "Teens & City Sports."

Will Our Pilot Get the Green Light? Complete and present a pitch for a pilot to TSN-2's president.

In each quest, students complete several main reading activities, where they read varied kinds of informational text, including typical workplace communications such as contracts and emails, and other materials, e.g., opinion pieces, articles, conversations, interview transcripts, and research reports. These "main" texts are each 1-3 pages in length, and are at the low-to-mid 8th grade reading level (average Lexile of 1010). For some activities, students are routed seamlessly to easier (6th grade reading level) or more challenging (mid-high 8th grade reading level) activities, based on their initial performance.

Embedded Assessment Approach

Evidence-centered design (Shute, 2011) requires game developers to ask:

- What do we want to say about the student?
- What observations would provide the best evidence for what we want to say?
- What tasks will enable us to make these observations?

Classroom, Inc. addressed these questions early in the game development process.

What do we want to say about the student?

Classroom, Inc. adopted its overall goal from the CCSS documents: Students will be prepared for college and careers by being able to read and comprehend rigorous, grade-level, nonfiction text; make connections among ideas in the texts; and consider a wide range of textual evidence.

What observations would provide the best evidence for what we want to say?

When presented with a variety of text types and formats in a game, students will show that they comprehend the text by answering questions correctly about what they have read.

What tasks will allow us to make these observations?

The tasks needed include giving students nonfiction text passages of varied types at the 8th grade level (as measured by Lexiles and CCSS complexity levels) within game mechanics that require them to read these texts and demonstrate their understanding before proceeding within the game.

CI and its game development partner, Filament Games, focused most early efforts on developing appropriate tasks in the form of game mechanics to elicit these observations. To further understand and operationalize the CCSS, CI carefully reviewed the CCSS documents, including sample texts, and recommended ways to ensure text complexity; reviewed the "Publishers' Criteria for the CCSS in ELA and Literacy" written by CCSS authors; consulted with experts in assessment and standards; and developed our own internal guidelines for text types to use and behaviors to elicit. CI then developed descriptions of mechanics to use, and guidelines for nonfiction text writers. To maintain workplace authenticity and narrative flow, CI used those mechanics throughout the game, often letting the narrative suggest placement, and mixing them up to keep students engaged. CI ensured ample coverage of each standard throughout the game, to generate sufficient information to assess students on each standard.

Because of competing requirements, *TSN-2* ended up with a different number of activities for each CCSS and a different number of “items” per activity, but enough to generate assessment data. (The game included 29 main reading activities/assessments with 260-265 items in all. The number of activities per standard ranged from 4 to 14; and the number of items per standard ranged from 50 to 87. See Table 1 for more specific breakdown.)

Sample Game Mechanics/Assessments

CI decided on nine game mechanics targeted to specific CCSS to use throughout the game, two of which--Idea Centralizer and Sorting Organizer—are featured in this paper. *Eight of these mechanics—not the open-ended Writing activity—served as both instructional tasks and embedded assessments.*

Piloting *TSN-2* provided valuable insight into how well the mechanics worked and why. In many cases, CI adapted these mechanics from existing ones used by Filament Games, to accommodate our aggressive funding and publishing schedule. A description and brief analysis of *two* oft-used mechanics follows.

Idea Centralizer (for CCSS RI 8.1 and 8.2). Students use this mechanic both to help them examine details that illustrate, explain, or support a main idea and to analyze the meaning of text within a larger context. For example, students read several ideas for TV shows. Knowing TSN-2’s goals for creating a TV show that will be popular with teens—and profitable for TSN-2—students use the mechanic to determine the elements of proposed programideas that do and do not meet TSN-2’s goals.

Figure 1: **Sample *TSN-2* Idea Centralizer Mechanic**

Students could have played up to seven *Idea Centralizer* activities in all. Over 300 students played an average of 4.5 *Idea Centralizers*, and answered 58% of the items correctly. This mechanic works best with clear criteria for text analysis. It has a straightforward interface that enables students to concentrate on the text. Its’ tabs accommodate longer texts, and is an effective mechanic for its specific use.

Sorting Organizer (for CCSS RI 8.3).Students compare details of three different people, places, or ideas. They must read and make judgments about text. In the following example, students compare the settings of three urban sports programs to determine which would make the best to feature in a pilot episode by determining which features of each setting meet the criteria of making a strong pilot TV show for TSN-2.

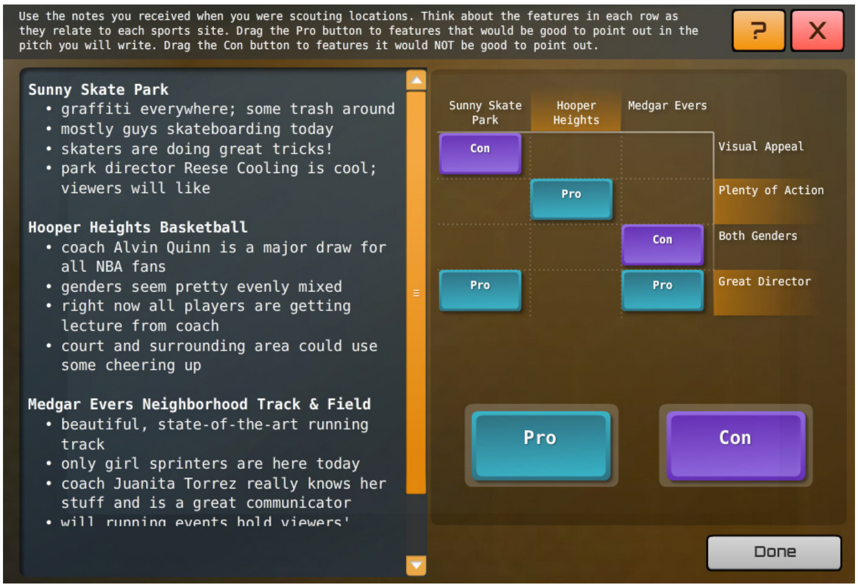

Figure 2: **Sample *TSN-2* Sorting Organizer Mechanic**

Students could have played up to two *Sorting Organizer*s across two “days.” Over 180 students played an average of 1.5 of these, and answered 63% of the items correctly. This mechanic works well because there is no possibility of giving away an answer in target text fragments and the activity does not call on students to focus on some details to the exclusion of others. Students had to carefully read text, think about it from different angles, and—when the mechanic interaction was complete—synthesize all the information to make comparisons. It was not, however, designed for sufficiently lengthy text.

Research Methods

CI worked with the NGLC Wave 2 evaluator, SRI International, to collect multiple types of outcomes and implementation data to assess program efficacy. CI sought to address the following questions related to student reading performance, this paper’s focus:

What are the challenges in designing embedded assessments, particularly for 8th grade CCSS for reading? This was relatively uncharted territory; learnings could help others seeking to instruct students and assess learning toward CCSS using technology.

- How do students perform on the four CCSS on embedded assessments, and how does this correlate with a standardized reading test, *Measures of Academic Progress Reading (MAP)*?

Participants

Sixteen teachers and over 400 students in 17 classes in eight NYC and Chicago public schools participated. Most teachers taught English Language Arts (ELA); others taught computers, electives, or ESL. Most used the program in regular classrooms with laptop carts. Almost all students were in 8th or 9th grade (96%); just over one-half were girls (55%); and the sample was ethnically diverse, with 53% identifying themselves as Black, 22% Latino, 13% Asian, and 11% White. Thirty-five students with special needs (8.4%) participated.

Measures and Data Collection

CI worked with SRI to collect multiple types of data. SRI collected standardized reading test data (pre and post-program data from an online assessment, the *MAP,* and an end-of-program teacher survey. CI collected brief pre- and post-program student surveys on deeper learning competencies and student engagement, and gathered CCSS student performance data through *TSN-2*’s embedded assessments.

Embedded Assessment Data

Because the use of embedded assessment data is evolving, additional information on CI’s approach and use of these data is provided. (Note that since the main game activities students played served as the assessments, the terms activity and assessment are used interchangeably here.) Students' responses within the game to the mechanics/embedded assessments were automatically captured and allowed CI and teachers to better understand students' reading competency. CI captured a wide array of data, including time spent in each activity, performance on all items in each activity, and response accuracy.

CI initially reviewed responses by mechanic and found that some worked better than others, and is now using those findings for new literacy games being developed. CI then examined the volume and accuracy of student responses around each CCSS.

For all but open-ended written items, responses were scored for accuracy, and then a simple *percentage correct* was calculated for all items within each activity. These percentage-correct scores were then averaged for each standard. This approach gave the same weight to each activity regardless of the number of items, and was akin to scores in a teacher's grade book, where a report card grade is an average of scores on multiple assessments, each with different numbers of items. This modest "grade book" strategy was used to calculate overall scores, and scores for each activity and each CCSS.

Results

While Classroom, Inc. collected a variety of data, this paper focuses primarily on reading outcomes, especially those from *TSN-2*'s embedded assessments. Highlights of survey results focusing on reading and learning are provided first, followed by embedded assessment results.

Highlights of Survey Results

Teachers agreed that *TSN-2* was a valuable and engaging educational experience for students, and that it had *a strong connection with the Common Core State Standards* (78%), and met *the learning needs of their students (67%)."* Two-thirds of teachers reported that learning gains were greater with *TSN-2* as compared to a traditional class. Teachers told us that *TSN-2* was a learning experience for them, particularly regarding the CCSS.

> *"I've never had anything that addressed CCSS like this!"*
>
> *"TSN-2 hugely addressed CCSS, particularly in vocabulary."*
>
> *"This game addressed the CCSS more than anything else I am doing."*

Students were highly engaged in the game, and learned by playing it, according to their survey responses. Large majorities of students agreed with the following statements:

> *Using the computer made learning more fun. (90%)*
>
> *I learned things that UI can use when I grow up. (90%)*
>
> *I am proud of my work in TSN-2. (88%)*
>
> *What I learned will help me do better in school. (88%)*
>
> *I am smarter than I thought I was. (86%)*
>
> *TSN-2 made me want to learn other things. (81%)*

Highlights of Embedded Assessment Results

This paper presents and discusses two sets of results from *TSN-2*'s embedded assessments: student performance on the targeted CCSS reading standards, and the correlation of the embedded assessment reading performance with performance measured by the standardized *MAP* Reading tests.

As Table 1 shows, struggling 8th grade readers who played *TSN-2* performed reasonably well overall on most standards, with percentages correct ranging from 43%-59% and averaging 53%. The texts were written at a rigorous low-mid 8th grade CCSS level. (Please note that the poorest performance—43% on Standard 8.3—was an anomaly and was largely due to one problematic mechanic that we are revising. If this activity type is ignored, the average percentage correct for Standard 8.3 increases to 63%.)

Main Activities	Number of Activities	Number of Items	Average Number of Students Who Played Each Activity	Average Percentage Correct
Standard 8.1 Cite the textual evidence . . .	14	57-62	196	52%
Standard 8.2 Determine a central idea . . .	6	87	127	59%
Standard 8.3 Analyze how a text makes connections . . .	4	66	178	43%
Standard 8.4 Determine the meaning of words and phrases . . .	5	50	168	55%
Overall	**29**	**260-265**	**174**	**53%**

***Table 1*: *TSN-2* Performance on Embedded Assessments by Standard**

Table 2 presents correlations between the *TSN-2* embedded assessment and the post-MAP Reading scores. *The correlations are moderate to strong, showing that TSN-2 is likely measuring the same traits as the MAP, and that this game does indeed assess students' reading comprehension. These data provide preliminary validation of this new game as an assessment of reading comprehension.* (Please note that correlations between embedded assessments and the MAP Reading pre-test were also performed, and were similarly high and also all significant at the 0.01 level.)

TSN-2 Embedded Assessment Scores		MAP Posttest Total Score
ALL Main Score	r	.685**
	sig	.000
	n	106
8.1 Main Score	r	.564**
	sig	.000
	n	106
8.2 Main Score	r	.602**
	sig	.000
	n	102
8.3 Main Score	r	.352**
	sig	.000
	n	96
8.4 Main Score	r	.653**
	sig	.000
	n	101

** Correlation is significant at the 0.01 level.

***Table 2*: Correlations between Embedded Assessment Scores and MAP Post Test Scores: Pearson Two-Tailed Correlation**

Analysis and Discussion

The focus of our analyses to-date has been to understand the data we were able to capture, and—most importantly—what those data say about students' reading performance. *TSN-2* by design, did not include a formal pre- and post-test. Although information on student performance was gathered throughout the game, with this short program exposure (20 hours), CI did not assess gains, but rather performance. New longer programs CI is developing will have this capacity.

Regarding student performance, along with embedded assessment data, we have teacher and student survey feedback, class observations and anecdotal evidence indicating that students were reading more and better, taking books out of the library, etc., after their *TSN-2* experience. We targeted struggling eighth graders and found those students in general getting 50-60% of the items related to comprehending 8^{th} grade level text correct, performing moderately well with difficult material. Feedback from students and teachers indicated that students, even those with special needs, performed reasonably well with the grade 8 informational text, and were motivated and engaged.

CI developed a learning game, not a standardized assessment. CI focused on engaging and challenging students with authentic workplace situations, and—at the same time—instructing and assessing those students on rigorous 8^{th} grade standards. The challenge was to engage students and have them move through the game without disrupting the flow with external assessments. Given the time and other limits, CI gathered considerable data useful to CI, teachers, and the broader learning community in the pilot.

Evidence from the *TSN-2* pilot indicates that it engaged teachers and students in CCSS-appropriate literacy activities, and that students were able to perform moderately well on rigorous nonfiction text within this game setting. Key remaining questions are how much assessment data game developers must collect and provide to have their games used both widely and well in real schools on a regular basis, and also be valid and reliable measures of student performance on the CCSS.

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Online Role-Playing Games and Young Adult Literature

Jen Scott Curwood, The University of Sydney, js.curwood@sydney.edu.au

Abstract: Drawing on theories of affinity spaces and traditions of online ethnographic research, this study seeks to understand the culture of physical, virtual, and blended spheres that adolescents inhabit. This paper highlights the ways in which youth use online role-playing games as a response to literature, such as *The Hunger Games* trilogy. Specifically, it considers how Tumblr, a microblogging site, offers a platform for readers to readily become writers and gamers. The analysis focuses on one young woman's creative writing and role-playing processes over time, and includes a discussion of how games can shape young adults' engagement with literature in and out of school contexts.

Introduction

A decade ago, the National Endowment for the Arts released *Reading at Risk: A Survey of Literary Reading in America*, which warned of a marked decline in youths' engagement with literature. The report contrasted books with digital media, arguing that the latter "often require no more than passive participation" and "foster shorter attention spans and accelerated gratification" (Bradshaw & Nichols, 2004, p. vii). Today, it's not uncommon to encounter media pundits and teachers alike echoing this argument that young people today don't read because they are too busy playing videogames, texting friends, or exploring uncharted online territory. By creating this dichotomy between technology and literature, it obscures the growing amount of empirical research that suggests that technology can enrich young people's understanding of literature and promote their multimodal composition skills.

As a result of greater accessibility and affordability of Internet-connected devices, youth are increasingly using online spaces to collaborate, communicate, and innovate. They see these spaces as a way to share their creative work that is often inspired by books, films, games, and other media (Black & Steinkuehler, 2009). Over the past two years, I have conducted an ethnographic study of *The Hunger Games* affinity space to gain insight into how fan culture can support the literacy practices inherent in writing stories, creating art, producing songs, and playing games. In this paper, I offer a case study of how one Australian adolescent uses Tumblr as part of a literature-based online role-playing game, and ask: How do role-playing games promote critical engagement with literature?

Online Affinity Spaces

Affinity spaces are physical, virtual, or blended spaces where people interact around a common interest (Gee, 2004). They contain multiple *portals*, or entry points, that offer diverse interest-driven trajectories, opportunities to learn with others, and paths toward becoming an authentic participant (Squire, 2011). Youth draw on a variety of modes and semiotic resources as they engage with their common passion in online affinity spaces (Curwood, Magnifico, & Lammers, 2013). While the field continues to theorize affinity spaces (Hayes & Duncan, 2012), further research is needed to shed light on the nature of literacy development and social interaction within online contexts.

Recently, several colleagues and I argued that an update to Gee's (2004) initial categorization of online affinity spaces was necessary (Lammers, Curwood, & Magnifico, 2012). We posited that contemporary affinity spaces have nine defining features: 1) A common endeavor is primary; 2) Participation is self-directed, multi-faceted, and dynamic; 3) Portals are often multimodal; 4) Affinity spaces provide a passionate, public audience for content; 5) Socializing plays an important role in affinity space participation; 6) Leadership roles vary within and among portals; 7) Knowledge is distributed across the entire affinity space; 8) Many portals place a high value on cataloguing content and documenting practices; and 9) Affinity spaces encompass a variety of media-specific and social networking portals.

Online affinity spaces offer fans a way to come together around a shared interest, across time and space. Moreover, many fan-based affinity spaces either emerge from games or include games as a part of the fandom. Prior scholarship indicates that games support complex forms of learning that include collaborative inquiry, the development of situated identities, and participation in a common discourse (Gee, 2003; Squire, 2006; Steinkuehler, 2006). This study seeks to add to this body of research by analyzing how affinity spaces and role-playing games shape young people's knowledge of literature as well as game design.

Methods

Research Context

To understand the literacy practices inherent in affinity spaces, I have taken a sociocultural, situated approach by observing and participating in the space associated with *The Hunger Games*, a young adult trilogy. Over the past two years, I have examined fan practices in various portals where young people write fan fiction, create art, produce videos, compose music, and design games (Curwood, 2013a; Curwood, 2013b; Curwood et al., 2013). Role-playing games, in particular, offer youth an opportunity to deepen their content knowledge, participate in social interactions, and develop their creative writing skills.

The Hunger Games, Catching Fire, and *Mockingjay* are part of a growing number of dystopian novels written for young adults. From 2008 to 2012, Suzanne Collins' trilogy sold over 50 million copies worldwide. Set in a post-apocalyptic world, Panem includes an affluent capitol, surrounded by thirteen impoverished districts. In the Dark Days, the districts rose up against the capitol. To remind the citizens of Panem that such a revolution must never happen again, they are subjected to the Hunger Games each year. The protagonist, 16-year-old Katniss Everdeen, must fight for her survival. In response to the trilogy, many fans have turned to the Internet; *Hunger Games* Top Sites currently tracks over 50 fan sites that have a combined total of 30 million page views.

Data Collection and Analysis

Data collection began with *systematic observation* to gain insight into the dynamics of communication and semiotic production in the online affinity space. I conducted multiple *interviews* with thirty focal participants via Skype, email, or private messages. Participants range in age from 11 to 17, and they represented a variety of countries, including the United States, the United Kingdom, Australia, and Canada. These interviews sought information about the factors that shaped their literacy practices, participation in online affinity spaces, and engagement with *The Hunger Games* novels. I also collected *artifacts,* including discussion board rules, online profiles, and creative work. Drawing on descriptive case analysis (Yin, 2003), I created case studies from focal participants in *The Hunger Games* affinity space. Using a thematic analysis framework (Boyatzis, 1998; Saldaña, 2009), I performed several repeated rounds of qualitative coding, gradually consolidating and refining the participants' discussions of their literacy practices into several broad patterns.

Focal Participant

In this paper, I offer a case study of a 17-year-old from Western Australia. Georgia is in her final year of high school and plans to apply to university. She explains, "I'm an arts student, so I don't take any math or sciences because I find them unnecessary, and also quite stifling – there is no room to create, or to see things from a peculiar perspective. I prefer subjective, creative subjects with deep analytical possibilities such as literature." While she fondly recalls her teachers introducing her to *The Picture of Dorian Gray*, *1984*, and *Macbeth*, she reports feeling frustrated by the prescriptive assignments that she often encounters in school. This year, Georgia said that she was "exceptionally fortunate to have been assigned a wonderful literature teacher. Her methods are engaging, and she encourages her students to interpret the text in their own respective ways… She understands, from reading my work in particular, how strongly I respond to certain texts emotionally – so she takes care to encourage my emotional responses."

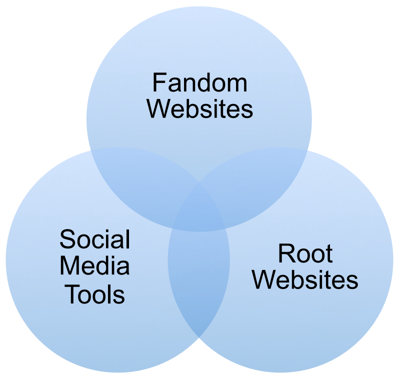

Figure 1. Types of portals into fan-based online affinity spaces.

Georgia is a fan of dystopian literature and she first read *The Hunger Games* in 2009. Georgia explains that the trilogy was not popular with her friends at school, and she wanted to "seek out like-minded people with whom I could converse and fangirl – people who would share my excitement and passion." Over the past four years, Georgia has been an avid participant in *The Hunger Games* online affinity space. She regularly seeks out opportunities on Mockingjay.net, TheFandom.net, Hypable.com, Twitter, and Tumblr to engage in with others within the fandom. Each of these portals represents a different type of entry point into fan-based online affinity spaces. While Tumblr and Twitter are social media tools and TheFandom.net and Hypable.com involve diverse fandoms, Mockingjay.net is a root website unique to the *Hunger Games* affinity space (see Figure 1). These various portals allow Georgia to engage with other fans and deepen her understanding of plot and the genre. More than that, they encourage Georgia's creative response to literature; she notes, "I like my creativity to flow, and I like to be inspired to read or write."

Findings

While Georgia is active on multiple portals within *The Hunger Games* affinity space, this analysis will focus specifically on how Georgia uses Tumblr to support engagement with literature and foster her literacy development. Based on a thematic analysis of Georgia's player profiles, game rules, and chat transcripts as well as multiple interviews, findings indicate that she uses the microblogging platform in a couple of key ways. Not only does literature-based role-playing give Georgia the opportunity to be a game designer, it also allows her to use her literary knowledge as an integral part of gameplay.

Game Design Matters

Georgia and a friend created *The Hunger Games Role Play*, which allowed other fans to propose characters, join in the role-play, and shape the game rules. Capitalizing on the rapidly growing popularity of the trilogy and the upcoming release of the first film, Georgia used Tumblr hashtags to share their RPG within the affinity space. At its peak in 2011, the game had twenty different players that represented each of the districts within Panem. Within the game, each character had his or her own Tumblr, which was linked from the Follow List page. This allowed each player to have multiple characters and to follow the Tumblrs of all other players within the game. In Figure 2, Georgia introduces the game and directs potential players to hyperlinked pages that explain how the game works and how they can join.

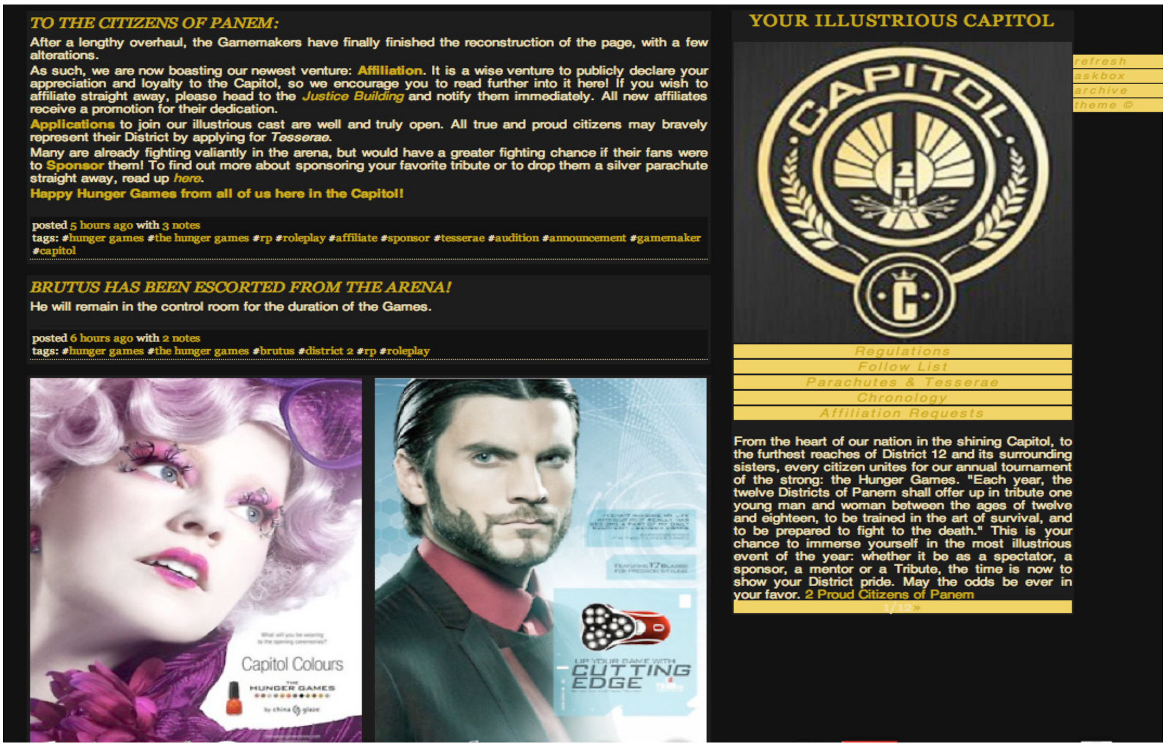

Figure 2. Screen shot from *The Hunger Games Role-play*

Georgia's first foray into role-playing was instrumental in informing her understanding of game design and game rules. In one interview, Georgia shared that the game rules developed over time and in consultation with other players. Since *The Hunger Games* involves a fight-to-the-death game, it was vital that the rules of engagement and the accepted levels of violence be clear at the onset. For that reason, one rule stated, "Being rude or derogatory to role-players while either one of you is out of character is not acceptable. Save it for the arena, children!" and another noted, "The official rating of this role-play is MA. In keeping with the spirit of the Games, violence is acceptable. However, if you wish to delve into all the gory details, please take advantage of the Read More feature for the sake of readers who may not wish to witness it." This latter rule allowed some players to include violent acts in detail while permitting others to chose to avoid reading such (perhaps gratuitous) descriptions. At the same time, this rule opened the opportunity to explore romances between characters.

As a game designer, Georgia quickly learned that part of designing a role-playing game is setting expectations for game play. For instance, some players were active daily while others either were not able or chose not to participate so frequently. Consequently, one rule stated, "if you are inactive for three weeks without declaring hiatus to us, we will option your role for another to fill." Additionally, role-playing games require clear rules and shared expectations. Part of this entails having a common discourse; with text-based online role-playing games, this extends to grammatical features of the game. One rule specifically addressed this: "Role-playing is fun and easy, but more enjoyable for readers and role-players alike when you use correct punctuation, grammar and sentence structure. Please refrain from "script format" (putting actions in *asterisks* between dialogue). You don't have to write full paragraphs, but a more professional structure is more descriptive, and reads better!"

Literary Knowledge Fosters Gameplay

In order to design *The Hunger Games Role Play*, Georgia needed to have an in-depth knowledge of the setting of Panem, the rules of the Games, and the characters. At the same time, her interaction with other fans within the affinity space meant that they could readily ask questions and that they would likely correct any of her misconceptions. The role-playing game gave Georgia her first opportunity to embody a character from *The Hunger Games*. To do so, she had to understand her character's motivations and interactions with others within the story. But she also needed to consider how *Hunger Games* author Suzanne Collins used descriptive language and dialogue to advance the plot. Rather than being a passive reader of *The Hunger Games*, Georgia's role-playing offered her the chance to become a game designer. It also allowed her to create two separate Tumblrs for the characters of Cinna and Cashmere. Over the course of 33,000 words, these role-plays gave Georgia an opportunity to develop her craft as a writer.

Georgia was drawn to Cinna, an important character throughout the trilogy, and Cashmere, a minor character in *Catching Fire*, and wanted to explore them more within the context of the role-playing game. While both characters hail from the Capitol, the similarities end there. Cinna is a brilliant stylist and a double agent who plots a revolution. Cashmere is a career tribute and previous victor of the Hunger Games. By role-playing these two characters, Georgia was able to delve into their histories, their motivations, and their voices. This can be seen in their Tumblr introductions and design (Figure 3). Cinna's introduction focuses on his role as a stylist; in her posts, Georgia shared some of her artistic interpretations of Cinna's designs. As Cinna, Georgia's writing is descriptive and poetic; she talks of practical beauty, obscure materials, and raging fires. In contrast, Georgia takes on an entirely different voice as Cashmere; she is confrontational, blunt, and haughty. A minor character in one novel, Georgia's writing as Cashmere allows her more room for exploration and interpretation.

With both characters, Georgia's literary knowledge is instrumental to her participation in the role-playing game. Writing in the omniscient third person, she focused on her characters' dialogue with others and her description of their surroundings, actions, and interactions. Role-playing demanded that Georgia be responsive to how others within the game advanced the storyline. For instance, Cinna and Katniss engaged in a lengthy exchange within the game. When another role-player introduced the idea that Katniss felt regret at her perceived weakness and poor decisions, Georgia-as-Cinna immediately responded,

> "You made the decisions that needed to be made. War is war; it is unfortunate that we had to resort to war to reach equality, but it was necessary. And look at all the good work you've done, and all the lives you'll save, the people who've liberated; you always were brave. The bravest woman I have ever known. You have never needed me to be brave." His words were earnest, heartfelt, things that he had always been reluctant to put into words. The line of his stitches and the stroke of his pencil spoke volumes more than his words; but they were all he had, here and now. Katniss needed to understand how she had changed the world.

While Georgia's literary knowledge fostered her engagement in the role-playing game, Tumblr's interactive design encouraged her interaction with others and offered her an eager audience for her creative work.

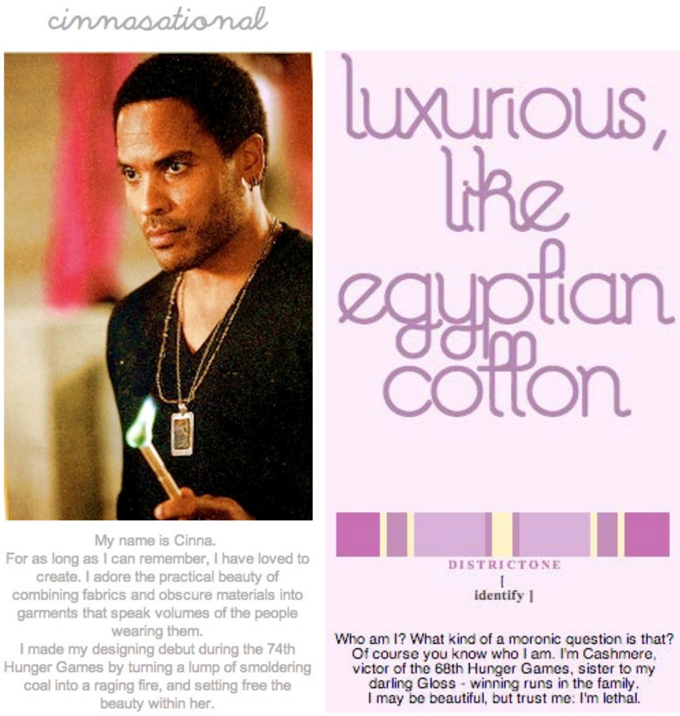

Figure 3. Screenshot from Cinna's and Cashmere's Tumblrs.

Implications

Research by the Pew Internet and American Life Project indicates that 80% of adolescents use online social network sites, 38% share original creative work online, and 21% remix their own creative works, inspired by others' words and images (Lenhart, Ling, Campbell, & Purcell, 2010; Lenhart, Madden, Smith, Purcell, Zickuhr, & Rainie, 2011). Clearly, many young people are using online spaces as a way to explore their interests, develop their identities, and engage with diverse modes and semiotic resources. Rather than situating novels and digital tools as two opposing forces in their lives, this study suggests that technology can in fact be a way to deepen young adults' engagement with literature. Unlike classrooms, most affinity spaces distribute opportunities for leadership across many individuals, texts, and tools (Gomez, Schieble, Curwood, & Hassett, 2010). For students like Georgia who are disengaged with school and result the prescribed nature of their literary experiences in English classes, online role-playing games offer a powerful way for them to demonstrate their leadership, develop their literacy skills, and engage in self-directed learning.

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Frames at Play: Situated engagement with research ethics games

Benjamin DeVane, University of Iowa, ben.devane@gmail.com
Margeaux Johnson, Amy Buhler, Michelle Leonard, University of Florida
margeaux@ufl.edu, amybuhl@uflib.ufl.edu, mleonard@uflib.ufl.edu
Richard Ferdig, Kent State University, rferdig@gmail.com

Abstract: Scholarship in educational research has argued games are promising learning tools because players take on fictional identities and roles to build new knowledge and skills. Analyzing usability data from a detective game about research ethics called Murky Misconduct, this paper argues that players use situated and overlapping "interpretive frames" (Bateson, 1972) to formulate responses to in-game controversies. Drawing on data sourced from "think-aloud" verbal reports, this paper argues that player-testers, who are graduate students in STEM disciplines, take up shifting interpretive frames as they confront in-game controversies related to research ethics.

Introduction

Academic and research misconduct appears to be increasing in prevalence among graduate students at research institutions (McCabe et al, 2001). Graduate students in science, technology, engineering and mathematics (STEM) often lack a rich understanding of proper ethical research practice, especially in the domains of falsification and fabrication of data, and plagiarism (FFP) (Leonard et al., 2010). The 2007 America COMPETES Act and recent initiatives of the National Science Foundation have emphasized the importance of education about responsible conduct of research to enhance STEM research practices. The Gaming Against Plagiarism (GAP) project attempts to offer an experiential and context-driven model of research ethics education that allows students to explore issues of responsible conduct of research (RCR) practices in game-based settings.

Analyzing user testing data from a detective game about research ethics called Murky Misconduct, this paper argues that players adopt "interpretive frames" (Bateson, 1972; Goffman, 1974) - toward in-game controversies. Similar to what others call "evaluative stances" (Lemke, 1998), these frames shape how players construe meanings about, and formulate responses to, play-based points of contention. Further, we argue players' frames of interpretation draw on both their existing knowledge schema and the context of game play.

Theoretical Framework

Scholarship in educational research has argued games are promising learning tools because players take on fictional identities and roles to build new knowledge and skills (Shaffer et al., 2005; Barab, Gresalfi & Ingram-Gobe, 2007). According to this view, game players assume a "projective stance" relative to their character – partially assuming the values, practices and knowledge of the character's roles and contexts (Gee, 2003). Ethical controversies embedded within the "safe space" of game play can support players' development of a critical capacity for ethical decision-making (Simkins & Steinkuehler, 2008).

Elsewhere, we have called in-game activities that contravene expected social conduct "transgressive play" – actions that might be considered controversial in the real world. We have hypothesize that transgressive play may prompt a player to reflect critically, because of the cognitive dissonance or projective identification associated with a given game context, on her real world actions. This paper investigates how game players' construct interpretive frames for controversies from a socially-situated perspective (Brown et al., 1989), emphasizing the importance of social and material contexts - tools, roles and activities - to the practice of learning (Lave & Wenger, 1991).

In this paper we look at playability tests of a research ethics game and investigate participants' construction of interpretive frames (Bateson, 1972)) that shape their response to controversial ethical play. Frames are cognitive structures of expectation that make interpretation possible (Goffman, 1974) and result in dynamic predictions about the relationships between events, objects and people. Speech acts and other verbal reports constitute "surface evidence" of the cognitive schema and scripts underlying an interpretive frame (Tannen, 1993). In this paper we examine the organized expectations of players about the game, events in game and their activities (testing/playing) as they are evidence in the players speech acts during game play.

Methods

The user testing sessions employed “think-aloud” protocols to ascertain players’ thoughts about the game. “Think-aloud” protocols (Ericsson & Simon, 1984) ask participants to issue a constant stream of verbal reports that describe their moment-by-moment thoughts while performing an assigned tasks. Players were asked to talk constantly about what they were thinking, without planning or deliberation (Jourdenais et al., 1995). Ericsson & Simon (1984) contend that these verbal reports allow observers to make grounded inferences about a user’s cognitive processes relative to a given task.

Frame analysis and situated learning

Frame analysis examines the multiple, overlapping frameworks of meaning-making that people employ to make sense of the social and materials interactions in a given context (Goffman, 1974). A pediatric physician examining a child in a mother’s presence, for example, has to balance an ‘examination frame,’ in which she diagnoses the child in the scientific language of medicine, with a ‘consultation frame’, in which she builds rapport with the mother and answers her question using ‘everyday’ language (Tannen & Wallat,1987). These frames, according to Goffman, are revealed in the *footing* that participants assume in a social context. Footing is the social stance that, through the emotional and informational content of their utterances, a speaker adopts in a setting. These stances are revealed through elements of speech acts like evaluative language, repetition, inferences and moral judgments (Tannen, 1993). In this paper, we look at the way players employ different interpretive frames as they describe their game play.

Data sources

Part of a research project on research ethics and trangressive play, the data analyzed comes from the talk of two usability testers, called Player 1 & Player 2, as they participated in the “think-aloud protocol” as they play a game. The two usability testers were graduate students in a STEM discipline at a major research university. Both students were males between ages twenty and thirty: one was an international student from South Asia and one was European-American.

The usability testers played a mystery game prototype that is the last game in a three-game series about research ethics. In this game, the main character is a research ethics detective who is on a mission to uncover a researcher who, through his unethical practices, is threatening the reputation of the university and its students. In performing their investigations, players must uncover and evaluate evidence related to research misconduct. The evidence must then be used to support a theory about a person’s guilt or innocence (see Figure 1). A distinguished professor who is often cruel to his graduate students turns out to be the real culprit. In user testing, students, professors and stakeholders have found this process of accusing the professor to be controversial (see Figure 2).

Figure 1: Examining a text for evidence of plagiarism.

Figure 2: The distinguished professor slanders his student.

The data presented below comes from transcriptions of the two players' verbal reports at a point in the game where they began discover the truth about the professor's research misconduct. In the game, the professor tells the player that his graduate student, named Megan, had engaged in data falsification in order to cover up his own research misconduct. The player's' character initially suspects the student, and the player must discover and assemble evidence into an argument that exonerates the student (see Figure 3). Upon her exoneration, the student hints that the professor might be involved.

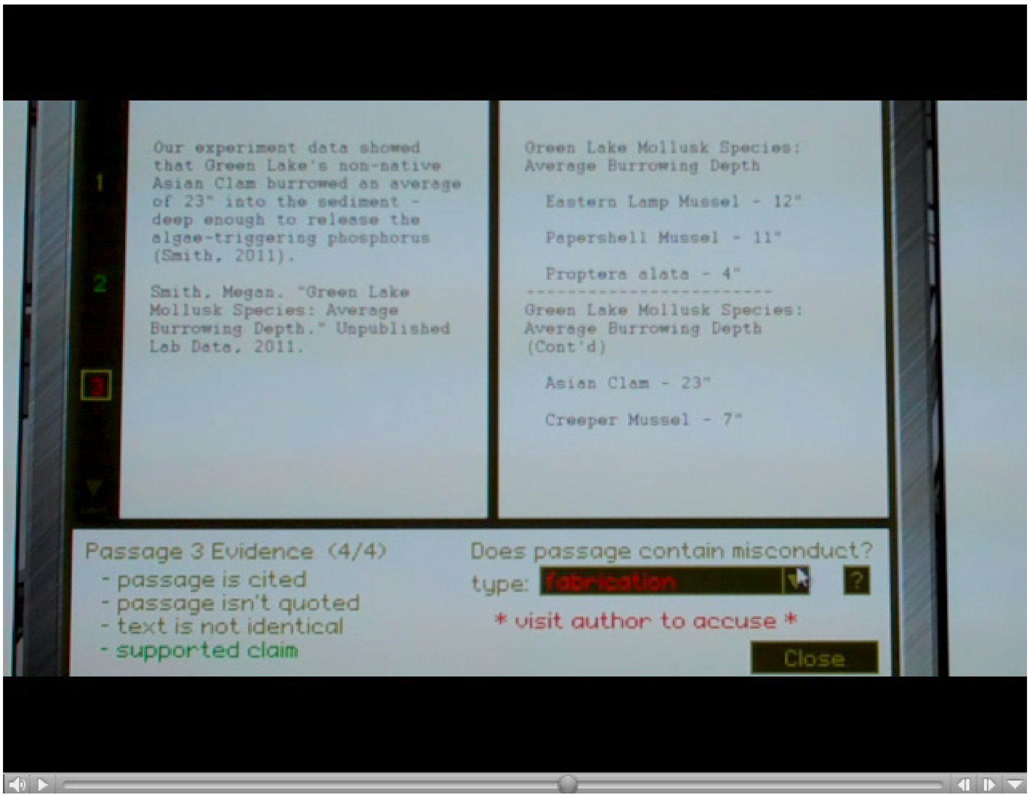

Figure 3: Player 1 uses evidence to argue for Megan's innocence.

Results

As player-testers of the game, Player 1 and Player 2 adopted very different footings toward the controversial play of accusing a professor. They took up these distinct footings in order to negotiate three overlapping interactive frames of the testing activity, which are: a) playing as a Character in the game; b) Testing a game; and c) Being a (graduate) Student. The Character frame entailed inhabiting the role of a character, unraveling the game's narrative, and overcoming challenges to accomplish goals in the game. The Testing frame involved evaluating and critiquing the game's narrative, interfaces and mechanics. Players, at times, shifted into the Student frame by speaking about their perspectives as a student and discussing a students' real-world dilemma compared to game-based situations.

Interactions: Proving a student's innocence

Player 1 and Player 2 adopted very distinct footings as they exonerated the wrongly accused graduate student. Player 1 very quickly took up the footing of an *expert tester* who understood the already complexities of research misconduct, and evaluated the efficacy of the game at simulating them. This was evidenced by his verbal report of the encounter:

> P1-24:55: [Addressing the proctor] Ohhh we have the-the thing here, where Professor Gibbons sabotaged her data. Which is an issue that we talked about in our grad group, of professors doing and so forth. Alright I liked that because Professor Gibbons asked you to accuse her instead of him to draw attention away from him. Whatever.

Player 1 began by addressing the silent proctor of the usability test, and composing an abstract that summarized what he was reading on the screen. He then related that in-game event back to real-world situations that he had previously discussed with other graduate students, exhibiting that he had background knowledge of the controversial event. He then evaluated his feelings about this event relative to the game's design. In doing so, he referred to the game's main character in the second-person rather than the first-person, thereby distancing himself from in-game persona.

The expert-tester footing of Player 1 privileges the evaluative work of the Testing frame, but leverages the projective work of Character frame and the experiential knowledge of the Student frame to support his performance of expertise. His habit of speaking to the proctor seems to convey that he is speaking to the designers and researchers who worked on this game. Throughout the testing session, Player 1 employed this discursive strategy often in his verbal reports - summarizing game events, distancing himself from the game, evaluating the game, and supporting his evaluation.

Player 2, meanwhile, shifted into the footing of an *engaged player* who was immersed in the character's narrative. When the fictional graduate student suggested that the professor might be at fault, Player 2 reacted in an interesting way:

> P2-32:35: [Reading the screen] I knew I had recorded that data. Although now that you mention it. [Addressing the screen] Yeah it did. Maybe PROFESSOR GIBBONS is the REAL plagiarizer. [Reading the screen] Since I used it as a source. Maybe you should check it for plagiarism. [Reacting] Niiice. I like this. Going straight to the top.

Player 2 alternated between reading the screen (see Figure 4), addressing the student character and exclaiming to himself, which shows his a footing as an engaged player. His out-loud reading of the screen demonstrates a close attention to events in the game that mirrors his exclamatory address of a fictional game character. The quickness and dramatic emphasis with which he addressed an in-game character, albeit in a silly way, signifies a tongue-in-cheek engrossment in the game's narrative. In this way, his footing foregrounds the Character frame, as he focused mostly on the literal events of game play. In contrast to Player 1, his enthusiastic evaluation indicates the manifestation of his thoughts as a player, rather than his critique as a tester.

Figure 4: Player 2 discovers the professor's culpability.

Conclusion

Scholarship often argues that learning in games is in part a process of identification, of coming to understand a new role, knowledge and values in the world. This process of identity transformation is often characterized as driven by the experience of inhabiting an in-game character. While further research may prove this to be true, it seems that this body of research has overlooked the way that the interactive frames that players construct serve to structure how they interpret their play and draw on existing knowledge schemas. How, for instance, might adopting a Tester frame heighten learners' reflective capacities? Or how might an engaged-player frame persuade a learner to try harder? As we continue this study on ethics, identity and controversy, we seek to address these questions and others.

Drawing on research emphasizing situated nature of learning (e.g. Lave & Wenger, 1991), the designers of learning games often attempts to embed contexts for learning *entirely within the game* (Gunter et al., 2008) in an effort to integrate conceptual knowledge with social practices. The game world, in other words, is thought to be *the context* for learning. The data presented in this paper suggests, alongside other research (see DeVane & Squire, 2008; DeVane et al. 2010), that players of "standalone games" actively construct an interpretive frame around game play, assembling a social context of learning that encompasses the game world. Players, in these limited cases, assumed distinct stances and frames for evaluating and processing game play; they drew on fairly heterogeneous knowledge schema regarding game play and prior knowledge of research ethics. Even as players were speaking only to a camera and silent proctor, their evaluative stances were *heteroglossic* (Bakhtin, 1981), reflecting multiple or quickly-changing discursive voices and assuming complex orientation-interpersonal meanings (see Lemke, 1998).

Perhaps the distinction between the interactive frames, which we use to interpret, know and act on the world, and the games we take-up as structures of desire is more tenuous than previously thought What if games are not separate spaces, but simulations of social life that borrow haphazardly from its unspoken rules? Fine's (1983) ethnography of fantasy gamers noted that researchers often view player's in-game and in-world selves as separate entities. Rather, Fine claims, players various frames and selves - e.g. expert, enthusiastic, student, critic - are often activated simultaneously on worlds of meaning, even in games. The player-testers of Murky Misconduct certainly seemed to do so, acting at different times as expert, student, moral authority, and defender of the downtrodden. The ways that players act, interpret and identify in learning games could be said to be the product of interlocking fictive and non-fictive interactive frames whose distinction is sometimes blurred. Researchers investigating play and learning would do well to keep this in mind.

Endnotes

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Game-like Design Model

Michael J. Donhost, michaeldonhost@me.com

Abstract: The author outlines a proposed game-like design model for teachers to employ when planning courses, units, and lessons. The author calls for teachers to work as designers of experiences and facilitators of learning. The design model consists of three phases: Wonder, Play, and Make. The Wonder phase is centered on inducing cognitive dissonance, defining roles and identities, and starting to unveil the challenge. The Play phase calls for teachers to design experiences that are similar to levels within video games, and that allow students to explore and tinker, while experiencing both challenge and support. The Make phase consists of clearly defining the challenge, setting the conditions for the Make, and a call to share. The paper concludes with additional possibilities and constraints.

Prologue

Imagine that you are a six-year-old child in a remote village in Ethiopia that has never seen printed materials, a road sign, or even words on packaging. One day a large box arrives with no explanation. You open the box to find shiny objects (Motorola Zoom Tablets) for you and 19 of your friends. You, of course, have no idea what a tablet is, but nonetheless, you are hooked. You figure out how to power up the tablet in less than five minutes and within five days you are using 47 preloaded apps. Within two weeks you are singing alphabet songs throughout the village. Within five months you have enabled the camera and personalized the desktop, though both rights had been intentionally disabled.

The story highlights what Nicholas Negroponte, the founder of One Laptop Per Child, attempted recently in two remote villages in Ethiopia (Talbot, 2012). The experiment (appropriate or not) highlights a seemingly natural, unfiltered, sequence of learning. The children experienced a sense of wonder, the freedom to play, and an opportunity to make.

How can we create experiences for students that follow a similar trajectory? Game-like learning is one possibility.

Designing for Game-like Learning

In game-like learning, students are dropped into inquiry-based, complex problem spaces in a manner consistent with what players experience in video games (Salen, Torres, Wolozin, Rufo-Tepper, & Shapiro, 2011, p.xi). As "the ultimate goal of the game designer is to deliver an experience" (Schell, 2010 p.21), game-like learning redefines the primary roles of the teacher to that of *designer of experiences and facilitator of learning*. As experience designers, there is much for teachers to learn from game designers.

Game designers often find themselves needing to teach the player through design rather than explicit instruction. Here's an example of teaching through design:

During a scene from the documentary *Indie Game* (2012), game designer Edmund McMillen describes how he teaches through level design. He demos a level on *Super Meat Boy* in which he intends to teach the player that they can scale walls. On the level being displayed, the novice player will arrive at a wall and look around for ways to move the character, Super Meat Boy, forward or up on the screen. Noticing that no viable options are available, the player experiences disequilibrium, as they cannot progress. With a void of options for moving forward or up, the user attempts the impossible, to scale the wall. The player tries and learns that Super Meat Boy's sticky blood exterior allows him to suction, albeit momentarily, to surfaces, thus allowing him to scale walls with ease (Pajot & Swirsky, 2012). No tutorials were provided, no Powerpoints presented, the game designer simply designed the environment to allow the learning opportunity to unfold.

Consequently, Game-like learning is a departure from the prevailing instructionist teacher-led classroom, to a decidedly constructivist and constructionist approach. In the paragraphs that follow, I endeavor to convey a game-like design model with the goal of helping teachers, aka *designers*, design with game-like learning principles for their courses, units, and lessons. The model is simple: Wonder, Play, Make.

Wonder

Last week, my two-year-old son struggled to locate a toy truck that was directly in front of him. He looked with wide-eyed excitement, but failed for what felt like minutes. To his mother and me, the task was simple, even though the truck sat nestled between 20-30 other toys. Alison Gopnik, a Professor of Psychology at the University of California, explained the curious condition we witnessed during a 2009 interview on the National Public Radio Show *Talk of the Nation*. Gopnik explained that babies and small children "…really seemed to be designed to learn" (Conan & Gopnik, 2009). She differentiated between adult consciousness as having a flashlight-like focus, and babies and small children experiencing the world with a lantern-like focus. The wider, lantern-like focus, dictates that babies and small children are necessarily bad at *not* paying attention, failing to disregard distractions. Being bad at not paying attention turns out to be an asset for early learning, as "…their consciousness is captivated by anything that they think might teach them about how the world works" (Conan & Gopnik, 2009).

What does it feel like to see the world with such a child-like wonder? Adult travellers may have the best idea. By putting themselves in strikingly different places and spaces, there is an awakening of consciousness as they try to make sense, and learn about their new surroundings. The feeling is likely associated with why many contemporary nomads refer to travelling as a drug, the powerful effect of seeing the world with child-like eyes.

The challenge then, for teachers, is to design experiences that awaken consciousness and ignite curiosity. The first step in design is to induce a state of cognitive dissonance for the learner, resulting in disequilibrium in thought, thus opening the door for learning to occur. Disequilibrium is uncomfortable, prompting the learner to be motivated and open to learn. The vacuum that is created when a learner experiences the unexpected, is stuck, witnesses discrepant events, or otherwise challenges their mental models, can act to awaken the curious mind.

After design induced disequilibrium ensues, the students are charged with taking on alternative identities and roles. Similar to a video game experience, identities and roles can range from the fantastical world of make believe to more reality-based assignments. The identities/roles allow students to connect with the larger narrative designed by the teacher, see problems from multiple viewpoints, and feel greater freedom in taking intellectual chances.

Wrapped up with the formation of identities and roles is often a slow unveiling of the larger challenge to come. The challenge is not fully disclosed during the wonder phase, rather hinted at in order to provide further definition to the narrative and shape student inquiry.

Inducing disequilibrium, shaping student identities and roles, along with starting to unveil the challenge, act in combination to create a state of Wonder. The students have "a need to know" (Salen et. al., 2011, p.16). "To truly learn, remember, and understand, your mind must be in a state of questing, of seeking to find knowledge" (Schell, 2010, p. xxix). Or in other words, as John Dewey wrote, "Eagerness for experience, for new and varied contacts, is found where wonder is found" (Dewey, 1910/1991, p.31). The students are now ready to experience Play.

To Play

Armed with a need to know, students enter an inquiry-based interdisciplinary environment that is designed for Play. In the classic book on play, *Homo Ludens*, John Huizinga asserts "in play, we may move below the level of the serious, as the child does; or we can also move above it – in the realm of the beautiful and the sacred" (Huizinga, 1950, p.19). We will attempt to achieve both.

In designing a playful experience aim to create a space for students to explore, tinker, feel challenged, and feel supported. The design continues to unveil the larger challenge and allows students to practice within the identities and roles introduced during the Wonder phase. Though not a necessity, actual games can compliment this phase of learning quite well, ranging from commercial video games to user created analog games.

Regardless of whether you choose to actually employ games, Play can feel game like. In designing for Play, we can follow the lead of game designers and think in terms of level design. A common feature of videogames is to "increase difficulty with each success" (Schell, 2010, p. 177). Thus, in games, players often work at the outer limits of their capacity as they develop skills. If a player struggles, their character (or avatar) may experience a momentary setback or even death, but ultimately, the player can simply start over. The player learns through the challenge, and through the failure. In addition to level design, game-designers can also teach us about importance of feedback. Within a game, you receive constant feedback on how you are doing. Feedback takes the form of "judgment, reward, instruction, encouragement, and challenge." (Schell, 2010, p.230) In video games, feedback helps to make you a better player.

Taking the lead from game designers, game–like design allows the learner to feel that understanding is attainable, but is always just a bit out of reach, or “challenging but not ‘undoable’” (Gee, 2007, p. 68). To create a level type feel, design a sequence of levels (or mini challenges) that slowly build student understanding and support exploration with just-in-time information, just-in-time guidance, and just-in-time surprises (to keep things interesting!). As the experience facilitator, allow time for students to explore levels and tinker with models. Allow students to learn through the challenge, and through the failure. Use feedback, lots of feedback to motivate, and to make students better learners.

The phase of Play should be messy, but if done well, it will be an engaging inquiry filled experience for students. “Play has the tendency to be beautiful” (Huizinga, 1950, P.10).

To Make

Having experienced a sense of Wonder and the freedom to Play with ideas, the student seeks to express their understanding, they seek to Make. Think of the Make phase of learning as an opportunity for the students to beat the Boss. In video games, players develop skills through gameplay and eventually test their skills against a variety of bosses. Often times, a game ends with a final Boss, a gnarly character that is sure to test the players’ full range of skills and their stamina. Except, in the classroom, the Boss comes in the form of a design-and-build challenge.

In the book *Makers The New Industrial Revolution*, former *Wired* magazine editor-in-chief Chris Anderson asserts that “We are all Makers. We are born Makers…” (Anderson, 2012, p.13). And subsequently, “We are all designers now” (Anderson, 2012, p.59). Anderson describes the emerging world of customization and individualized manufacturing that is evidenced in the success of companies like Etsy, and the forecasted growth of personal 3D printers and other fabrication devices over the next decade. We have reached a period where each person will have the ability to design and build in a way that only factories have done in the past, “…nothing is stopping you from making anything” (Anderson, 2012, p.66).

Now it’s time to launch the challenge in full and set the conditions for the Make. The goal is to have students experience “learning-by-making” (Papert & Harel, 1991, p.4), as they transfer the knowledge and skills that were developed during the Play phase, to a different context. They will develop design skills, such as: communication, collaboration, critical thinking, problem solving, creativity, and innovation.

The challenge is situated within the narrative, deepening the connection to identity and role, and placing the learner on a team. Student teams work, often in competition with each other, to design, build, iterate, and eventually Make a final product. Providing a student friendly rubric can help to guide progress and add structure to the (wonderfully) messy process of learning that will unfold.

As a learner, to Make is to test all of your assumptions, to learn through iteration, to learn from teammates, to make your thinking visible, and to express publicly what you currently know and understand. “There is no greater integrity, no greater goal achieved, than an idea articulately expressed through something made with your hands. We call this constant dialogue between eye, mind, and hand “critical thinking -- critical making” (Maeda, 2010).

At the culmination of a Make is a call to share. Sharing is often public and can take many forms, depending on the nature of the Make. The audience for a discrete lesson might very well be classmates, or peers in online communities. For larger Makes, invite experts in to judge the challenge. Experts can raise the stakes, increase the feel of authenticity, and add a degree of age appropriate professionalism to the process.

Epilogue

The game-like design model outlined in the previous sections is not meant to rigidly define a singular path toward designing game-like learning environments. The reader might rightfully question whether students should Make during the Play phase, or Play during the Wonder phase. The answer is YES! I do however offer the following pair of rigid design constraints if you choose to employ this model for game-like design, students need to start in the Wonder phase, and conclude in the Make phase.

Many of the ideas outlined above are not new, rather they represent a mash-up of educational thought from the last century, with emerging technologies that are only now coming into focus.

The design model as presented can be employed on any level, from course, to unit, to lesson. Design the experience – Wonder, Play, Make.

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Mitigation of Cognitive Bias Through the Use of a Serious Game

Norah E. Dunbar[1], Claude H. Miller[1], Bradley J. Adame[1], Javier Elizondo[1], Scott N. Wilson[1], Stephanie G. Schartel[1], Brianna Lane[1], Abigail Allums Kauffman[2], Sara Straub[1], Judee K. Burgoon[3], Joseph Valicich[3], Elena Bessarabova[1], Matthew L. Jensen[1], Jeffrey Jenkins[3], Jun Zhang[4], and Dallas Morrison[1]
University of Oklahoma[1], University of Texas–Permian Basin[2], University of Arizona[3], University of Michigan[4]

Abstract: Intelligence analysts gather information from a variety of sources, process the information incrementally as it is received, and are under constant pressure for quick and accurate judgments. A serious training game called MACBETH was designed to address and mitigate cognitive biases undermining analysts' accurate collection and interpretation of intelligence. The IARPA SIRIUS program directed attention to two cognitive biases that are the focus of this experimental study—*fundamental attribution error,* and *confirmation bias.* In this experiment, 703 participants played the MACBETH game or engaged in a more traditional learning method—a video describing the same two cognitive biases. Results demonstrated the game to be more effective than the video when explicit training methods were combined with repetitive play.

Intelligence analysts gather information from a variety of sources, process the information incrementally as it is received, and are under constant pressure for quick and accurate judgments. In his book *The Psychology of Intelligence Analysis,* Heuer (2006) calls this process, "a recipe for inaccurate perception" (p. 27). To address the cognitive biases undermining accurate collection, interpretation and synthesis of intelligence by intelligence analysts, our interdisciplinary team of experts has designed, built and tested a serious training game called *MACBETH (**M**itigating **A**nalyst **C**ognitive **B**ias by **E**liminating **T**ask **H**euristics)* to improve the ability of future intelligence analysts to make decisions with greater systematic processing, and less reliance on cognitively biased heuristics. In this paper, we present the results of our first experiment testing the ability of MACBETH to mitigate two such biases: *the fundamental attribution error (FAE),* and *confirmation bias (CB).* Below, we will explain these two biases, describe the MACBETH game, and outline an experimental test designed to demonstrate the efficacy of MACBETH at mitigating these forms of flawed heuristic processing.

Confirmation bias is the tendency to search for and interpret information so as to confirm one's preconceived assumptions, expectations, or hypotheses (Nickerson, 1998). Heuer (2006) suggests at least 15 different strategies for "keeping an open mind," including identifying alternative models, thinking backwards, playing devil's advocate, using deferred judgment, and cross-fertilization of ideas. Although we could not implement all of these methods within the game, several of them were used in the MACBETH experiment. The FAE is a function of the tendency to over-emphasize stable, personality-based explanations (i.e., dispositions) for behaviors observed in others, while under-emphasizing the role and power of transitory, situational influences on the same behavior (Harvey, Town, & Yarkin, 1981). The MACBETH game was designed to make the differences between dispositional and situational cues salient, and reinforce the use of situational cues while discouraging the use of dispositional cues when making threat assessments about a source.

The details of the game mechanics and the development of the game are beyond the scope of this paper, however, they are described in detail elsewhere (Dunbar et al., 2013). In MACBETH, players assume the role of analysts who are presented with a series of fictional scenarios of impending terrorist attacks. The object is to figure out who the bad guys are, what weapons they will use, and where their attack will occur. In one turn, player-analysts have the opportunity to gather two pieces of information about the person, location, and/or weapon from various sources of intel, whereupon they can make a hypothesis, or aid another analyst with information that proves or disproves the other analyst's hypothesis. Some of the information analysts receive is vague, and therefore needs to be substantiated by first earning, then expending a chip allowing them to verify the relevant intel. Analysts earn chips by playing the mini-game "Archive," wherein they look at past case files and, based on situational and dispositional cues, decide whether a given suspect represents a threat or not. At the end of a turn, or if the players make or change their current hypothesis, they are asked to verify their decision using information they've gathered in previous turns. Once a player-analyst has gathered enough information, s/he can submit a final hypothesis and potentially win the round. Throughout the game, analysts learn about the cognitive biases and receive both implicit and explicit feedback encouraging them to seek disconfirming information, disprove their hypotheses, rely more on situational cues, and be made aware of their susceptibility to biased decision making processes and errors. To test the efficacy of the game, we compared it to a control condition; a training video informing viewers about the nature of cognitive biases using entertaining vignettes presented by a professorial host in a lab coat. The experiment not only manipulated different versions of the MACBETH game to determine the most effective treatment conditions, it also tested the interactive internalization of information via an immersive game against the more traditional, passive learning afforded by an instructional video.

Of course, games can vary in their effectiveness depending on the nature of game mechanics introduced, and the conditions within which they function during game play. And although there is some debate as to whether explicit training is as effective as more implicit approaches allowing players to figure out on their own the best way to proceed, the literature suggests priming information (i.e., providing explicit material about biases) can generally be effective at ameliorating bias. Accordingly, the experimental manipulations included either did or did not intersperse instructions, making hasty generalizations and over-reliance on dispositional attributions salient to players throughout the game. This formed the reasoning for the following hypothesis concerning the use of explicit priming to reduce CB and FAE:

> H1: MACBETH with priming increases pre- to post-game bias familiarity and knowledge and reduces biased judgments relative to MACBETH without priming.

The research literature also suggests longer playing time and repeated play opportunities should enhance a game's ability to improve knowledge—and in the present case, reduce biased judgments. To test these assumptions, we manipulated the amount of game play time available to players. They were assigned either to a short (30 minute) or long (60 minute) initial game session, and to either a single-play, repeated play in the laboratory, or a repeat play take-home condition.

> H2: Relative to shorter game play sessions, longer sessions increase pre- to post- bias familiarity and knowledge and reduces biased judgments.

> H3: Relative to single-shot game play, repeated play (whether in-laboratory or take-home) increases bias familiarity and knowledge and reduces biased judgments across time periods.

Method

Participants

Participants included 703 students recruited by mass emails and classroom announcements at two Universities in the Southwestern and South-central United States. The sample included 329 females (47%) ranging between 18 and 62 years of age (*M* = 22.03, *SD* = 5.34).

Procedure

Upon arriving at the lab, an experimenter randomly assigned participants to one of the 10 experimental conditions in blocks. Participants were administered pretest measures, followed by the experimental treatment (either one of the MACBETH game conditions or the control video), and then post-treatment measures. At the end of their first session, participants assigned to the repeat play condition scheduled a follow-up appointment to be completed in the lab within one week. Those assigned to the take-home condition were given login instructions for the game administered online. All participants were paid $20 for their participation in each lab session and were reminded they would be emailed a link to a follow-up survey in 8 weeks. All participants were also paid $30 upon completion of the 8-week survey.

Conditions

Priming

Participants played a version of MACBETH explicitly addressing the biases (i.e., the priming condition), or a version not explicitly addressing this information (i.e., the non-priming condition). The priming version contained pop-up quizzes at various points in the game at which time players were given text defining the bias followed by a multiple choice question checking whether they'd learned the definition correctly. If they answer the question incorrectly, they were given the definition again, followed by a repeat of the question, and were allowed to advance only after correctly answering the question. The FAE quiz appeared the first time players entered the archive mini-game, whereas the CB quiz appeared the first time they entered the hypothesis testing portion of the game.

Duration

Players were randomly assigned to 30- or 60-minute versions of the game; and in both cases saw a clock counting down the time remaining in their game.

Repetition

Players were randomly assigned to either the in-laboratory single-play, the in-laboratory repeated play, or take-home repeated play conditions. At the end of their first visit, those in the in-lab repeat-play condition were asked to sign up for a second lab visit one week later (those in the repeat-play condition who did not return for their second play session, i.e., 21%, were considered to be single-play participants). Those assigned to the take-home condition played one session in the lab and then were given a sheet of login instructions for the game which directed them to play the game at home at least twice—but they had the option of playing as often as they liked within a two week period. Of the 102 players assigned to the take-home condition, 50 logged in at least one time from home and played an average of roughly 53 minutes per session. Take-home players who did not play at home were also considered to be single-play participants.

Measurement

We used three different measures for knowledge about the biases. First, participants rated their own perceived familiarity with the biases on a 7-point scale. Second, they completed a 6-item test matching definitions with biases. Third, they responded to three multiple choice exam-style questions in a bias application test presenting short scenarios for which participants identified the bias being illustrated.

For CB bias mitigation, six new items were developed to measure CB (modeled after Rassin, 2010) which included scenarios such as: "You find out someone borrowed your laptop last night without your permission and let the battery run all the way down. You think it's one of your brother's friends because he's always forgetting his own laptop, and he was probably around last night. If you wanted to test your suspicion, what question(s) would you ask others about this person?" Each item offered a similarly brief scenario followed by four response options, two of which indicate confirming responses (coded -1), and two of which indicate disconfirming responses (coded +1), so possible responses ranged between -2 and +2, with lower scores indicating higher levels of confirmation bias. Of the six items, three were included at the pretest and three at Posttest 1, with the three pretest items used again at Posttest 2, and the three Posttest 1 items used again at the 8-week follow-up posttest. The three items used at each test period were summed to create one scale which we called "NewCB" ranging from -6 to +6. Three Confirmation Bias Application Measures (CBAM) were developed based Watson's (1968) card flip paradigm, and used as a second CB mitigation measure.

For FAE bias mitigation, two different measures were used; one consisted of four vignettes adapted from Riggio and Garcia's (2009) "Ron's Bad Day" scenario. Each vignette presented a short scenario in which the central character experienced either positive or negative consequences due to their choices or the circumstances. The scenarios were sufficiently vague as to allow participants to build their own attributions about the causes of consequences within each narrative. After reading a scenario, participants were presented with 10 situational (e.g. broken down car, the weather, work environment) and dispositional items (e.g. personality, attitude, skills and abilities), and asked to indicate the degree to which each played a role in the consequential outcomes. The second FAE measure, adapted from Stalder (2000), required participants to watch a short video in which two participants play a trivia game with one randomly chosen to make up questions for the other. Participants were asked to evaluate both characters' knowledge, memory, and ability. Because the situation could make it appear as though the questioner is more knowledgeable than the contestant—even though each was randomly assigned their roles—the degree to which participants rate the questioner as superior to the contestant indicates FAE through the discounting of situational cues.

Results

Analysis Overview

For all analyses reported below, to capture results from participants' posttests following the last time they played MACBETH prior to the 8-week posttest, we conducted repeated measures MANCOVA using a "last post" variable that recoded Pretest, Post 1, Post 2 and 8-week Post into three levels (pre, last post, and 8-weeks). The reason for this is a function of the way SPSS deals with missing data (i.e., using "listwise deletion" for repeated measures analyses, which removes cases that do not include data for all time periods (pre-test, last post-play test and 8-week follow up posttest). Creating this "last post" variable allows for more accurate detection of differences between repeat players and non-repeat players by including the repetition variable as a factor. The analysis used a 2 (duration; 30/60 minute) x 2 (training type; priming/no-priming) x 2 (location; University 1 or 2), x 2 (Sex of Subject; M/F) design with age, extroversion, openness, agreeableness, conscientiousness, emotional stability, need for closure, horizontal individualism, vertical individualism, horizontal collectivism, confirmation proneness, personal need for structure/personal fear of invalidity, sensation seeking, handedness, logic aptitude, computer comfort, gaming experience entered as covariates. All non-significant covariates were dropped and analyses rerun using the reduced models.

Recognition of Cognitive Biases

Familiarity

Participants rated on a 7-point scale their degree of familiarity with each of the biases, from very familiar to very unfamiliar. Every cell had the means and SDs calculated for CB and FAE. Prior to game play or control video treatments, participants reported low levels of familiarity with each bias (paired-samples t-tests assessing pre- to posttest knowledge were significant at p <.001 for all conditions).

Somewhat unexpectedly, there was a slight increase in the players' familiarity rating from their last posttest to the 8-week follow-up. When looking at each bias and cell individually, there are higher mean familiarity ratings at the 8-week posttest than at last posttest. All 8-week means were higher than the Posttest 1 means, and all the differences from the pretest to 8-week were significant: CB: t(560)= 5.53, p<.001; FAE: t(559)= -8.74, p<.001, Posttest 1 to 8-week, CB: t(559)= 5.51, p<.001; FAE: t (559)= 4.43, p<.001, and Posttest 2 to 8-week, CB: t(247)= 3.82, p<.001; FAE: t(247)= 4.73, p<.001. Participants who played the explicit training (primed) game reported higher levels of familiarity at the 8-week posttest (CB: t(515)= 6.378, p<.001; FAE: t(474)= 4.58, p<.001). However, those who watched the video reported significantly higher levels of bias familiarity (CB: t(559)= -2.51, p=.001; FAE: t(559)= -3.03, p=.002) relative to most game conditions. There were however no significant differences between the best game condition (60 minute, primed, repeat play) and the control video.

Bias Matching Test

The second measure of bias recognition directed participants to match the definitions of the six biases with the appropriate bias names in a "drag and drop" exercise. This measure was scored such that participants earned one point for each correct match, with scores ranging from 0 to 6. All differences from Posttest 1 to the 8-week posttest were significant t(714)= 11.89, p<.001 as were the differences from Last posttest to the 8-week posttest t(714)= -9.09, p<.001. There were no significant differences from the participant's last in-lab posttest to the 8-week posttest for duration, training type or number of times participants played MACBETH. However, for the matching test, the control video outperformed all game conditions t(58)=2.40, p=.02, including the best version of the game, t(73)= -2.31, p=.02.

Bias Application Knowledge Test

To test the same repeated measures ANCOVA across 3 time periods (pre, last post, and 8-weeks), duration, repetition, training type, sex of subject, and location were included as IVs, along with the above covariates. Only extroversion and logic aptitude were included as covariates in the reduced model. Findings revealed a significant between-subjects main effect for training type F (1, 527) = 8.74, p < .003, η^2 = .008, and a significant quadratic within-subjects time period by training type interaction, F (1, 527) = 6.66, p = .01, η^2 = .01. The priming group (M = 1.35, SE = .04) and the video control (M = 1.35, SE = .04) were not significantly different from one another (p = .08), however, they were both significantly different from the no-priming group (M = 1.35, SE = .04), with both being significantly higher than the no-priming on CB knowledge. The time period by training type interaction demonstrates again that, although the video control group had greater bias knowledge at the immediate posttest, they also had greater knowledge loss at 8-weeks. Although comparisons between the video controls and the priming groups show no significant differences at 8-week post, t (327) = -1.29, p =. 20, the video control group was significantly better then the no-priming group, t (279) = -2.22, p =. 03.

For FAE, no covariates were retained within the reduced ANCOVA model. Results indicated a significant quadratic within-subjects main effect for duration, F (1. 527) = 13.12, p < .001, η^2 = .02, a between-subjects main effect for training type, F (1. 527) = 7.79, p =.005, η^2 = .02, and for location, F (1. 527) = 6.50, p = .01, η^2 = .01, along with a significant quadratic within-subjects time period by duration by sex interaction effect for time X duration X sex of subject, F (1. 527) = 8.83, p = .003, η^2 = .02. The main effect for time period suggests FAE knowledge increased from pre-test (M = 1.22, SE = .04) to the last posttest (M = 1.40, SE = .05), and then decreased again at the 8-week posttest (M = 1.31, SE = .04), however, it nevertheless remained marginally higher (p = .06) after 8-weeks than at pre-test. The training type main effect suggests priming (M = 1.34, SE = .04) led to greater FAE knowledge than no-priming (M = 1.19, SE = .05) and the control video led to more knowledge (M = 1.69, SE = .11) than both priming and no-priming conditions (all p <.05). The location main effect indicated University 1 participants scored better overall on the FAE Knowledge test (M = 1.42, SE = .05) than University 2 (M = 1.21, SE = .04). Examination of the simple effects suggests both males and females performed better in the video than the game conditions, however, controls had greater knowledge loss at 8-weeks compared to all game conditions. For males, the 30-minute game condition had greater knowledge loss than the 60-minute condition at the 8 week post, t (258) = -2.65, p =. 001, but for females this difference was not significant, t (259) = .81, p =. 42.

Mitigation of Confirmation Bias

To test CB mitigation, repeated measures ANCOVAs were conducted, using both the CBAM and the NewCB scores as the DVs. None of the covariates were retained for the CBAM analysis, and there were no significant results for any of the between-subjects factors, or for test period. The NewCB analysis included agreeableness (p = .026) and need for closure (p = .024) as significant covariates, and yielded a significant test period by training type (priming vs. no priming), and repetition (one-shot, repeat-play, take-home, video) as between-subjects factors. There was a significant interaction, $F(2, 804) = 3.32$, p = .036, η_p^2 = .01, with participants in the priming condition demonstrating a greater reduction in CB than no-priming participants (see Figure 1; those in the video condition are also shown for reference). This effect appears to be fairly robust as little decline between the last posttest and the 8-week posttest is evident.

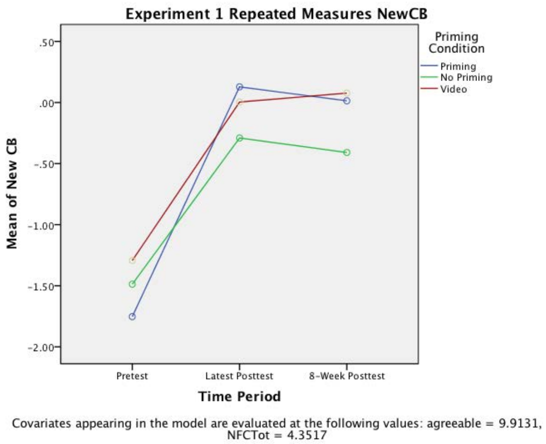

Figure 1: Repeated Measures NewCB Means by Condition

Mitigation of Fundamental Attribution Error (FAE)

To analyze the FAE data, mean scores were calculated for dispositional and situational cues, and a separate repeated measures analysis was run for each group of cues. Scores for dispositional situational cues were coded so higher scores indicated increased reliance on each cue. ANCOVA tests used the same IVs as above, for which no significant covariates were retained, revealing a significant main effect for time period, Wilks' λ = .985, $F(2, 574)$ = 4.42, p = .012, η^2 = .015, indicating dispositional scores for all participants changed over the three time periods.

Between subjects effects revealed a significant main effect for time $F(2, 1150)$ = 4.06, p =.018 , η^2 = .007, such that participants in all conditions reduced their reliance on dispositional cues across the three time periods, pre, M = 5.12 (SD = 1.60), last post, M = 4.71 (SD = 1.77), and 8-week post, M = 4.65 (SD = 1.62). There was a significant time by duration by repetition interaction, Wilks' λ = .989, $F(2, 574)$ = 3.08, p = .074, η^2 = .011, with between-subjects effects indicating 30-minute duration participants in the video condition reporting slightly less reliance on dispositional cues across time periods, $F(2, 1150)$ = 3.70, p = .025, η^2 = .006 (Figure 2). Despite lower scores for each time period, repeat game players showed a trend of decreasing reliance on dispositional cues from latest post to 8-week post, whereas those in both the one-shot and control conditions showed a slight increase in reliance on dispositional cues. Participants in the 60-minute play conditions reported decreasing reliance on dispositional cues across the three time periods, with those in the one-shot condition reporting the least reliance on dispositional cues at the 8-week test time.

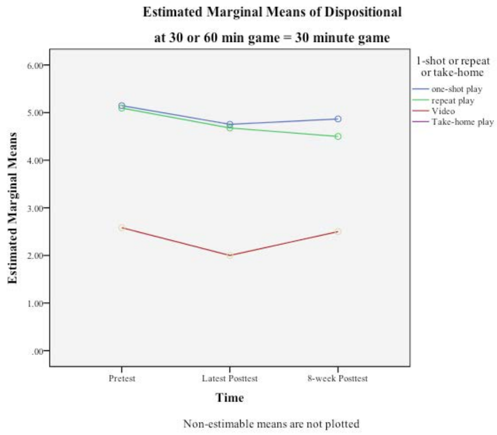

Figure 2: Repeated Measures Dispositional Cue Reliance Means by Condition

MANOVA analyses for preference of situational cue scores at pretest, last post, and 8-week post found no significant effects for any of the IVs or covariates. To examine how participants reacted to the questioner and contestant featured in the Stalder video task (Stalder, 2000), a repeated measures ANCOVA was conducted using the above IVs along with sex included as a fixed factor. A significant multivariate effect for time period, Wilks' λ = .972, $F(1, 544) = 15.45$, $p < .001$, $\eta^2 = .028$, indicated participants in all conditions reduced their bias across time periods. No significant effects were found for duration, Wilks' λ = .999, $F(1, 544) = .519$, $p = .472$, training type, Wilks' λ = 1.00, $F(1, 544) = .071$, $p = .79$, or repetition, Wilks' λ = 1.00, $F(2, 544) = .09$, $p = .914$, although the main effect for sex was marginal, Wilks' λ = .994, $F(1, 544) = 3.15$, $p = .076$, $\eta^2 = .006$, and the between-subjects effect for time period indicated participants in all conditions reduced their bias from last post, $M = 2.12$ ($SD = 1.38$) to 8-week post, $M = 1.22$ ($SD = 1.11$), $F(1, 544) = 130.51$, $p < .000$, $\eta^2 = .24$.

Discussion

Hypothesis 1 predicted, relative to no-priming, MACBETH with priming should increase pre- to posttest reduction in biased judgments, and this expectation was supported in part: There was a significant main effect for priming on the NewCB scale responses, indicating the primed game conditions produced greater CB mitigation relative to the non-primed conditions, and this effect was qualified by a marginally significant 3-way interaction between priming, duration, and location which suggests participants at one location appear to have responded more favorably to priming in the 30-minute game, whereas those at other location appear to have responded more favorably to priming in the 60-minute game. Priming also produced greater FAE bias reduction along with a significant interaction between priming and time period. Both versions of the game successfully reduced the use of dispositional cues from pretest to posttest 1, however, the no-priming and control groups showed a reversal at the last posttest, with a significantly greater use of dispositional cues relative to the priming group, for which reduced use of dispositional cues persisted after 8 weeks.

Analyses of game duration on bias familiarity, knowledge, and judgment provides partial support for H2. Although little effect was found for duration on biased judgments in pre- vs. posttest comparisons, and there was no significant effect for duration on FAE judgments, a significant main effect was found in the NewCB judgment test, which was qualified by a duration by location interaction indicating 30-minute players performed better at one location, whereas 60-minute players performed better at the other. While longer duration was found to enhance learning and bias mitigation in some cases, most of the knowledge- and judgment-related tests revealed only minor improvements, with some showing no effect. However, several results indicate longer duration of play was very effective when combined with priming and repeat play, particularly in the optimal (60 minute, primed, repeat) experimental group. When compared to single-play, repeate play offers several clear benefits: As support for H3 suggests, repeat players performed better on judgment tests than players in the single play condition, and as the mitigation results using the NewCB scale show, repeat-play clearly outperformed single-play. Moreover, with regard the FAE measures, there was a significant repetition by time period interaction indicating increased use of situational cues by those in the repeat-play conditions across time periods.

Conclusions

Although one might expect some decay in the effects of MACBETH on bias mitigation measured 8 weeks after game play, the positive de-biasing results appear largely robust to the passage of time. Across bias mitigation tests within the optimal game conditions, our analyses show only a very slight nonsignificant drop in the two primary bias mitigation measures, implying the knowledge gained by playing MACBETH appears to be internalized and retained, It seems clear that repeated play and longer duration both work to increase the positive effects of MACBETH game play. Moreover, Relative to implicit training alone—as provided by the no-priming conditions—the priming conditions were clearly more effective, suggesting explicit training with definitions and quizzes offers the most optimal method of training within the game. Although the explicit training provided by the video appears to be more effective at teaching knowledge about the biases, knowledge alone does not translate into actual reduction in bias use.

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Empirical Research on the Impact of *Morgan's Raid*

Lyle Franklin, Paul Gestwicki, Ronald Morris, Ball State University
ljfranklin@bsu.edu, pvgestwicki@bsu.edu, rvmorris@bsu.edu

Abstract: We present an empirical evaluation of Morgan's Raid, an educational video game about Civil War history in Indiana. The game was designed for integration with Indiana fourth grade curriculum on state history. We conducted a qualitative study with six elementary school students, and the body of data included field notes and pre- and post-intervention interviews. Three major findings emerged regarding these students: after playing the game, they exhibited increased knowledge and understanding of the historical context and geography; playing the game increased the students' empathy for both soldiers and civilians in the 1860s; and the constructive nature of learning led to unexpected interpretations of the game. These findings have implications for the design of serious games as well as future research.

Introduction

Games are powerful tools for education. A well-designed educational game can engage students with challenging contexts, rapid feedback, and opportunity for practice. However, it is important to remember that no matter how carefully designed the learning intervention, student learning is constructive. Each player will approach an educational game with a different set of background knowledge, skills, and experience. Given that games teach experientially and that learning is constructive and subjective, formal evaluation of educational games is critical to the scholarly approach (Glassick et al., 1997).

Morgan's Raid is a turn-based strategy game designed to teach Indiana's Civil War History to elementary school students (3:15 Studio, 2011). The game meets state standards for Indiana's fourth grade curriculum, incorporating aspects of social studies, geography, and mathematics. Our study is motivated by a deceivingly simple question: what does a player actually learn by playing? This question reflects the constructive and subjective nature of game-based learning, and it is most appropriately approached via qualitative research methods (Stake, 2010). We proceed by providing some background on the game and its historical basis. We then describe our research design and discuss what was found in the data. The subsequent discussion section frames our data within the broader educational context.

Background

The American Civil War was pivotal in U.S. History. The country was divided: disagreements concerning the role of slavery led several states to secede from the Union. The major events of the Civil War are well-known: the Battle at Fort Sumter, the Battle of Gettysburg, and the signing of the Emancipation Proclamation to name a few. Less widely known are the exploits of Confederate Brigadier General John Hunt Morgan (Thomas, 1985; Ramage, 1995; Horwitz, 2001). From June 11 through July 26, 1863, General Morgan led over 2,000 Confederate cavalry on a raid of civilian towns in Tennessee, Kentucky, Indiana, and Ohio in what would become known as "Morgan's Raid." Morgan disobeyed orders to stay in Tennessee and Kentucky when he brought his men over the Ohio River into Indiana. He moved from town to town, taking supplies and horses, frightening residents, and evading Union forces. In order to escape his pursuers, Morgan's troops destroyed dozens of bridges, railroads, and government buildings across Union territory. He engaged Union forces and local militias on several occasions, most famously at the Battle of Corydon (Indiana), which would be one of two Civil War battles fought in a free state. Morgan's forces tore a path through southern Indiana and much of Ohio before their defeat and surrender at the Battle of Salineville in northeast Ohio. Morgan left no evidence of his motivation for the raid, making it an excellent topic for the discussion of what "history" is and how it is done.

Morgan's historical raid represents Indiana's most direct involvement in the Civil War. Although Indiana's state curriculum requires fourth grade social studies teachers to cover the historical raid, the state-approved textbooks offer just a single page on the subject. This is a missed opportunity to give context to the Civil War. Without a sense of context, the Civil War seems to students to be an event that happened a long time ago to people who lived far away from here; in order to gain an appreciation for the significance of the Civil War, students must not only learn what happened, but what life was like for people during that time (Gestwicki and Morris, 2012) . A simple recounting of major events and battles in a textbook is not sufficient: teachers must utilize alternative teaching methods to impart the importance and complexity of these events to their students. Was General Morgan a petty thief, a courageous leader fighting for his cause, or even a war criminal or terrorist? Issues of this complexity require deeper immersion in the subject matter—the kind of immersion afforded by video games.

Figure 1: The player allocates orders to Morgan's raiders at each town.

The video game *Morgan's Raid* was released in Summer 2011 and is free to download and play. The player controls General Morgan, and the goal of the game is to maximize Morgan's score while raiding towns in southern Indiana, avoiding Union soldiers, and escaping into Ohio. It is a turn-based strategy game, and each turn consists of two parts. First, the player is presented with a map of the immediate area and chooses an adjacent town as the new destination. Then, upon arrival, the player chooses how to Morgan should distribute orders to his men (see Figure 1). The options include Militia, Horses, Supplies, Scout, Railroad, Impede, and Chaos, with the specific options available depending on the town. An explanation of each choice is provided within the game by Basil Duke, who was Morgan's brother-in-law and second-in-command (Duke 1867). The player allocates orders to these targets, and this allocation affects the game state. For example, Impede slows down the Union pursuers while Scout provides Morgan with more orders in the next town. After assigning orders, a brief animation shows the town burning, accompanied by the sound of horses running, people screaming, and gunshots (see Figure 2). Score is tracked as "Reputation," which represents both Morgan's positive reputation in the Confederacy and his negative reputation in the Union. The more chaos the player causes, the more Reputation is earned. *Morgan's Raid* is a single-player game, and Reputation provides an incentive for replay.

The game uses scripted narratives in the introduction and ending of the game. The introductory scene explains the context of the Civil War and tells Morgan's story up to the Raid. There are two possible endings to the game: either Morgan escapes to Ohio to continue his raid or, counter to historical fact, he is captured by the Union in Indiana; each has its own cinematic sequence. Regardless of the ending, an epilogue follows that explains the actual history of Morgan, including a comparison of the player's path to the path of the historical raid (see Figure 3).

Gestwicki and Morris (2012) explain how the original educational goals of Morgan's Raid include learning about important historical figures from the period, what communication and transportation was like at the time, strategic time management, the fact that Morgan's Raid was a chase, and the behaviors of both Morgan and his Union pursuers during the raid. However, they also describe how the design of the game changed significantly through the prototyping and development process. Such changes are expected during software development, particularly when following an iterative and incremental development methodology (Keith, 2010). This presents a motivation for this study, in which we investigate the actual impact of Morgan's Raid on elementary school players.

Figure 2: An animation is played while the player raids.

Research Methods

This study is designed to identify how playing *Morgan's Raid* affects students' perceptions of the Civil War and Morgan's historical raid. We desired to develop a deep understanding of how specific players interact with the game as well as the shape of their discourse before and after, and so we adopted a qualitative research approach (Stake, 2010). In particular, we used a semi-structured interview protocol before and after play (see Table 1), along with observed think-aloud gameplay. Interview and observation data were transcribed and iteratively coded following Saldaña (2009). By focusing on the specific details of a small group of players, we are able to construct a detailed description of their gameplay experience. That is, we seek to understand what these students really learned, which may or may not align with the game's intended goals—an understanding that would not be possible with a quantitative study. This approach was partially inspired by the qualitative studies reported by Ito et al. (2009), who use ethnographic methods to describe how youth interact with digital media and networks.

The study was conducted at a private elementary school in Indiana. Ten interviews were conducted, and in data reduction, six of these were selected for analysis to achieve gender balance. Although *Morgan's Raid* is designed to be integrated into the fourth grade classroom, it was not feasible to conduct the study precisely as students were learning Civil War History. Hence, we selected fifth graders, all of whom had ostensibly learned about the Civil War and Morgan's Raid in the previous academic year. None of the participants had previously played the game.

Findings

The coding process and subsequent analysis revealed three major themes in how playing Morgan's Raid affected the students' knowledge and perceptions of the historical raid and the Civil War as a whole. The first of these is that, after playing the game, the students exhibited increased knowledge and understanding of the historical context of the raid, including geography. The second is that playing the game improved students' empathy for people living in 1863, both of civilians and of Morgan in particular. Third, the constructive nature of learning led students to conclusions that were not always aligned with the designers' intent. Each of these is explained in more detail below.

Historical Context

The pre-intervention questions revealed the students had only the most basic knowledge of the historical raid prior to playing the game. All but one of the students had heard of the raid, yet when prompted to explain its significance, the students could gave only the simplest overview. "General Morgan went to a couple towns and took food and supplies that he needed" was a typical response. Two of the students believed the raid was only a single battle.

The game succeeded in dispelling this misinformation. When asked to explain the significance of the raid after playing the game, the students universally gave a more detailed and correct explanation of events. They correctly stated that John Morgan was a Confederate General raiding towns in Union territory. Most students gave a more specific geographic description of where the raid took place: beginning in Kentucky, moving through Indiana, and ending in Ohio.

Figure 3: The ending narrative compares the player's path with Morgan's historical path.

Many of the post-intervention responses involved more fine-grained geographical knowledge the students gained from playing the game. The majority of the students correctly recognized that the player's in-game starting location was in southern Indiana. The game explicitly instructs the player to travel to Ohio, but relies on the player's knowledge of geography to determine that they must travel east from the starting location to reach Ohio. One student also indicated he learned more about the populations of towns during that time period; this information is shown on placards for each town (see Figure 1).

In addition to a greater knowledge of geography and a more detailed summary of events, the students also exhibited an improved understanding of General Morgan, including his personal history and motivation. Several students indicated they learned that Morgan was a businessman as well as a slave owner. The majority of students stated that General Morgan was trying to escape to Ohio while being pursued by Union soldiers, and that he took supplies and horses from towns in the process. When students were asked why they chose particular actions, the subjects demonstrated sound rationale—for example, "[I picked] supplies because one of your soldiers might get hurt and you would need supplies to fix that." and "I picked impede so I could block the Union and escape town and go to the next one."

Empathy

After playing the game, students exhibited a greater sense of empathy for the people who lived during that time, as well as for General Morgan. Initially, several students expressed surprise that they would be playing the role of a Confederate General rather than a Northerner. One student even stated he was thought it was cool that he would be playing as the "bad guys." Another student, when asked why he chose not to destroy the local railroad to slow down the Union pursuers, responded, "I didn't want to destroy the railroad because destroying the RR would hurt us." Although he was playing the role of General Morgan, the student said destroying the railroad would hurt "us", meaning the Northerners. These responses show that the students viewed the events of the Civil War from a distinctly Northern perspective. This is not an unexpected finding considering that they were all from Indiana. However, when asked in the post-intervention, "What do you think about what General Morgan did?" many responses were sympathetic towards General Morgan. One student responded that taking supplies and horses from civilians in order to continue raiding was a smart move for General Morgan. Another student said she believed General Morgan took supplies because he had to, and that General Morgan did not want to break any laws. Three of the six students stated they believed General Morgan was "following his beliefs."

The students also displayed greater empathy for civilians living in Indiana during the Civil War. When asked about life in the 1860s before playing the game, most students mentioned the lack of technology that we enjoy today. Some students mentioned the hardships resulting from rationed food, and one mentioned that children would play outside more often. The same question was asked after having played the game, and the responses were much more focused on the impact of the raid. The students commented on how afraid the townspeople in Indiana would have been when General Morgan was raiding towns in the area. Two students expressed anger at the thought of Morgan raiding their town. One student described how he would feel if he was living in a town Morgan was raiding: "I would feel frightened and would want to hide behind something because he destroyed everything in sight." Another student said, “I would be afraid they would take someone from my family or hurt them.” When asked what she thought of the raiding sound clip and animation (see Figure 2), one student said, “I think it is realistic. If something like that was happening, people would be scared and terrified that something might happen to their children or their houses.” These responses indicate an emotional connection to the people living during the 1860s in Indiana that was not evident before playing the game.

This empathy extended to the development of counterfactual personal narratives. When asked what kind of person she believed General Morgan was, one student responded, “He was a person who wanted to have what he wanted to be okay, not to be against the law.” This was an unexpected response, as General Morgan had no qualms about breaking laws in the North. Furthermore, no formal or dramatic elements in the game suggest otherwise. Background information about General Morgan is given through a scripted narrative at the introduction and conclusion of the game, however the player determines the actions of the in-game representation of General Morgan. By placing the player in the role of General Morgan, some players seemed to project their own value system onto the protagonist.

Constructive Learning

Learning is a constructive process—a learner’s background knowledge having an important impact on what mental models are built from an experience (Ambrose et al., 2010). Our data showed many cases where the students interpreted elements of the game differently from the designers’ intent, and these can be traced to their understandings of these words or ideas outside the game context. In a previous quotation, we saw that a student assumes “supplies” means “medical supplies” despite the absence of such a connection in the game’s formal or dramatic elements. In another case, a student claimed that “Scouting will let us look ahead for an ambush.” While it’s true that scouting, in general, might be used to find an ambush, Basil Duke’s expository text tells the player that scouting grants more orders. Here, the player has chosen an option for a good reason, and in fact had a good gameplay experience because of the choice, even though the rationale was not correctly tied to the game mechanics.

The non-game connotations of words had a strong impact on the players’ planning and interpretation. One player avoided the Chaos option, stating, “Not as much chaos, might want to keep it on the down low.” This is counter to historical Morgan, but the player saw “chaos” as a negative thing to be avoided. Another student stated, “Chaos raises reputation, I don’t think reputation is good.” The student must understand “reputation” only in the negative sense, even though it represents the score of the game—a score in which higher is better. Such interpretations may explain why the students focused their attention on the immediate goal of escaping the Union and getting to Ohio, contrary to the designers’ intent that the players would attempt to maximize reputation in the process.

Discussion

The students exhibited positive learning outcomes from both dramatic and formal elements of the game. Recall of historical facts was more tightly bound to the dramatic elements; we saw this particularly with the introductory and concluding cinematics. This mode of student learning and assessment is very conventional, instructional videos being an established complement to other classroom activities. On the other hand, empathy was built by the player’s actions, particularly shown students’ reflections on raiding. Whereas pre-intervention interviews showed a self-centered focus on technological absence in the past, post-intervention interviews showed that students felt hope and fear for civilians in the 1860s. The students’ understanding of historic geography blends across the cinematics and gameplay.

The game design intentionally obfuscates the immediate impact of a raid. Basil Duke provides “feed forward” about what certain orders *will* do, but the only feedback about what they did do—with respect to the game’s state—is in a reputation change. Even here, it is not clear how much reputation was gained or how it related to the numerous decisions made in assigning orders. As a result, the students become frustrated as they try and fail to build a mental model of the rules. The lack of feedback also contributes to students’ developing potentially-counterfactual personal narratives. Players build mental models based on what they do and the feedback they receive—a common theme in game design books and game formalisms (Cook, 2007; Koster, 2012). This building of mental models *is* learning, and so it marks the primary affordance a designer has to align player learning with specific learning objectives. This study demonstrates how, in the absence of immediate feedback, players may build mental models that are inconsistent with a serious game’s learning objectives.

The findings show how the constructive nature of learning can lead different players to build different personal narratives from the gameplay experience. In a formal school setting, it may be necessary to scaffold the play-based learning in order to mitigate any counterfactual historical ideas a player may have developed. For example, a discussion of Morgan’s intention may help a player reinterpret “chaos” as it was intended by the designers.

This study was over a very short time and conducted separately from normal social studies lessons. The curriculum provided for *Morgan's Raid* describes how discussions and activities can be used in a social studies class following the playing of the game, and some of these are clearly designed to target the kinds of counterfactual learning outcomes that we observed. Our subject pool was small and localized, although they were representative of many elementary school communities; future studies can build upon these findings to investigate long-term and generalized impacts of the game.

Conclusions

We have shown that these players met the intended learning objectives of *Morgan's Raid* with respect to historical and geographical facts as well as decision-making. The players also developed more nuanced empathy for people of the 1860s. This shows that *Morgan's Raid* has met its learning objectives as originally designed despite various changes having been made during the iterative prototyping and development processes. Our data also show how each student's learning was unique, as predicted by constructivist learning theory: the students' interpretations of the game were strongly influenced by their background knowledge. A player's pre-existing connotation for terms such as "chaos" or "reputation" directly affected how the player planned their moves and interpreted the feedback, regardless of the in-game use of these terms. This suggests that more rigorous playtesting with the intended audience, and the adoption of qualitative research methods into this process, can help reduce unintended consequences of game design decisions.

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Packing for Another Planet: Learning Scientific Methodology Through Alternative Reality Gaming

Heather Graham, Pennsylvania State University, hgraham@psu.edu
Eric Church, BreakAway, Ltd., echurch@breakawayltd.com
Christopher H. House, Pennsylvania State University, chrishouse@psu.edu

Abstract: We use an alternative reality game (ARG) to teach a wide variety of STEM topics as a planetary exploration activity. The program is organized as a professional development workshop for middle and high school science educators and has included teachers from many fields: life sciences, physical sciences, and technology. Teachers are grouped into teams of scientists and charged with designing a scientific mission of discovery to another planet. The game culminates in a competition for funding. The ARG relies on the combined expertise of all participants and illustrates the highly interdisciplinary nature of science. The game combines fieldwork, laboratory experiments, and directed readings, as well as independent research. User reviews from before and after the use of the teaching ARG indicate that participants were more engaged and found it easier to apply large amounts of data and concepts when presented through a cohesive storyline with a defined goal.

Epistemic Training in the Scientific Method

Traditional secondary curricula generally separate the science and mathematic disciplines into discrete courses with little to no connection between them. The major topics – biology, chemistry, physics, and Earth sciences – are taught in isolation from on another. Mathematics are generally a complete aside from science or, at best, incorporated as a mechanism for manipulating numerical data in laboratory assignments (Frykholm & Glasson, 2005). When offered, laboratory experiments are rarely truly experimental but rather designed to be illustrative (AAAS, 2009). With time and funding always limited it is difficult to include long-term, hypothesis-driven experiments into the standard curricula.

The typical arrangement of topics gives students a completely inaccurate idea of scientific training and practice. In actuality, scientists must be able to evaluate data and practices from outside their specialty and are required to understand many technological applications in order to collect or utilize data. Scientists generally work closely with engineers and are required to accurately communicate needs and understand the limitations of any technology employed. The increased reliance on computational methods requires scientists to have a good working knowledge of computer science and mathematics and to likewise be able to work in conjunction with specialists in these fields. Outside of secondary classrooms the basic scientific disciplines are highly dependent on one another and the boundaries between STEM fields are not practical. The interdisciplinary nature of astrobiology emphasizes learning from all disciplines and offers many areas of interest to students. Natural connections are made between fields as disparate as biology and astronomy when a student must contemplate, for example, the metabolisms that would be supported by a particular star system.

The educational requirements and certification process for secondary science teachers places great emphasis on mastering content and pedagogical practice. Few post-graduate science teaching programs require an independent experimental project. Instead, teachers are schooled in the mechanics and philosophy of the scientific method without ever being able to fully employ the scientific method or design an experiment (Hammrich, 2001; Schwartz *et al.,* 2004). In this way scientific data and the scientific method are treated as declarative knowledge, without practice (Dreyfuss & Dreyfuss, 1986). This ARG emphasizes learning within the appropriate epistemic frame (Shaffer, 2006). The game creates procedural knowledge by immersing participants in the business of hypothesis building and experimental design in a self-directed approach.

This ARG emphasizes project-based learning. Hypothesis building and experimental design are essential to the activities and final project. Student groups are supplied with a body of data from an exoplanet and then directed through fieldwork and experiments that can help them interpret the data. Participants are given instruction in effective literature search to guide their thinking. The end goal of the ARG is for the student groups to design a mission to the exoplanet, complete with hypothesis-driven scientific goals. The student groups are encouraged to explore questions of their choosing and the mission can be specific to the strengths and interests of their group. The final project is a presentation of the proposed mission and a request for funding for this work from a panel of reviewers. Student groups use information gained from lectures, experiments, and literature research to guide their decisions. Final missions must include not only a hypothesis but define the impetus for the hypothesis, it's importance to NASA science goals, and expected outcomes.

Astrobiology: the Interdisciplinary Search for Life in the Cosmos

While unfamiliar to many, astrobiology is the field of science concerned with the origin, evolution, and distribution of life in the Universe. Workers in this field include biologists, ecologists, chemists, planetary scientists, geologists, astronomers, and physicists. Astrobiology is a highly technological field and data collection and interpretation requires the expertise of mathematicians, computer scientists, and engineers as well. Astrobiology provides an ideal context for presenting principles and data from all basic sciences and STEM fields and illustrates the connections between the sciences. Most importantly for teaching science to a younger audience, astrobiology provides a creative, exciting scientific application. Recent high profile missions like the Mars Science Laboratory aboard Curiosity, the Cassini Orbiter, and the Mercury Messenger are making the discoveries in this field more widely known to a general audience and have captured the imagination of the public.

Learning goals for the astrobiology workshop are taken from the NASA Astrobiology Roadmap and emphasize NAI science objectives. Some of the topics covered in the workshop include:

- The Drake Equation and the Scale of the Universe
- Understanding Evolution and Geologic Time
- Defining Life: The Chemical Nature of Biology
- Planetary Formation and Atmospheres
- Interstellar Real Estate: Defining the Habitable Zone
- How to Find a Habitable Planet
- Life Detection – will we know it when we find it?

An astrobiology workshop has been offered as part of the Pennsylvania Space Grant Consortium Summer Professional Development Series for five years however, only in the last two years has the curriculum been taught as an ARG. Workshops can last from 5 to 10 days and are taken for credit, fulfilling the continuing education requirements for licensed teachers in Pennsylvania, Maryland, and New Jersey. Content for the workshop is aligned with standards so that teachers can use specific activities from the workshop to meet mandated curriculum goals and address specific test topics. The workshops are held at the Pennsylvania State University and facilitated by faculty and researchers from the Pennsylvania State Astrobiology Research Center, an associate facility of the NASA Astrobiology Institute.

Team Selection, Planet Assignment and Initial Datasets: Setting Up the Game

The ARG is played by teams of teachers. Teams are selected by the workshop facilitators in order to increase the diversity of scientific discourse. The workshop is open to teachers in all STEM fields and it is our goal to create teams with one representative from each of the basic sciences as well as some scientific generalists. Each team has five people with at least one biology teacher and at least one physical science (chemistry or physics) teacher.

Prior to their arrival the teachers are asked to read *How to Find a Habitable Planet* by James Kasting (2010). This text includes a thorough outline of the scientific background behind astrobiology and planetary habitability and is directed towards a general audience. On the first day of the workshop participants have a book club style Q&A with the author. This requirement ensures that all teachers, regardless of their scientific specialty, have the same requisite basic knowledge and ensures meaningful conversation with facilitating scientists.

Each group is given a body of data from an imaginary exoplanet. This dataset includes the mass, radius, density, surface temperature, distance from star or parent planet as well as orbital parameters of the planet. The data set also describes the method used to detect the planet. Additionally, each group receives a set of three spectra for their planet that we imagine has been retrieved through space telescopy. Each planet has a surface as well as atmospheric spectra and a third piece of information unique to their world. A wide variety of spectroscopic techniques are included in the initial data packets - absorption and reflectance - and include many types of electromagnetic radiation, as well as different quantitative systems. This type of information will likely be unfamiliar with the team but interpretation of the spectra are also given with the initial data. Emphasizing the highly collaborative nature of scientific research, participants are encouraged to discuss their datasets with the facilitators as well as one another.

What the participants do not know is that the data are collected from four very real target planets of astrobiological interest: Mars, Io, Europa, and the Archean Earth. Using real planets allows the facilitators to supplement the data given to the groups throughout the term of the workshop depending on the interests of the group. For example, if a group becomes interested in atmospheric characteristics “new data” can be “downloaded” from the imaginary orbiter to help the group better define their mission. Conversely, groups will often want data that simply does not exist yet for a planet. This, in and of itself, is an important lesson about the realities of scientific research. By realizing the paucity of some kinds of data the teams begin to develop targets for their mission plans.

The final piece of data that teams are given at the onset is an actual geologic “sample” from the surface of their exoplanet. Each group receives a substrate that we can imagine came from some sort of “sample return mission”. Teams will use the surface samples from the exoplanets in actual experiments to help them understand the nature of their planet. The “samples” are different varieties of ground sand that are spiked with various minerals, salts, and organics. In fact, one “sample” (the sample from Archean Earth) even contains DNA. These mixtures are designed to be representative of the spectroscopic data and give each planet unique chemical characteristics that support different hypotheses for life on that planet.

Playing the Game: Lab, Field, and Library

The epistemic format of the ARG is meant to mimic the working habits of a research scientist. Essentially, this is a game about collecting and analyzing data and building new research directions based on those data. To that end, instruction is given primarily through data collection as part of laboratory experiments, fieldwork and independent research of primary literature. These activities each offer teams new data that will inform the direction of their mission proposal.

Learning by Doing

Groups conduct a variety of experiments with the “sample return mission” substrates that direct their mission planning. We use a re-enactment of the Viking Lander gas exchange experiments to prepare groups for experimentation and to give training in hypothesis building. We review the procedures used and discuss the assumptions behind the protocol used in the Viking mission. The facilitator demonstrates possible false positives as well as false negatives and participants design experiments that can test these scenarios.

Having learned how to examine an analytical protocol and the basics of experimental design participants are led through a series of experiments to help them learn more about their exoplanet of interest. Participants are encouraged to develop follow up experiments for every activity and facilitators work with groups to make these possible. One experiment requires groups to attempt to extract DNA from these substrates. Of course only one sample contains DNA but there are often false positive results due to contamination. Lecture and reading material emphasize the longevity of the DNA molecule and groups must consider other data from their exoplanet to decide if their positive result indicates extant or fossil life.

Another laboratory experiment teaches participants how electromagnetic spectroscopy is collected and how to interpret it. This is especially useful for understanding the exoplanet data sets they are given and also to help them understand the literature. The vast majority of data we have on other planets comes from remote sensing of the surfaces of these bodies. In order to illustrate spectroscopy we have participants build their own spectrometers from cardboard boxes and diffraction grating. We then perform flame tests on their “sample return mission” substrates in order to identify major elements from the surface of their planet. We use this test to confirm or complement surface spectra that were given in the initial data set. This activity covers a variety of core subjects including optics, wave physics, and chemistry and helps participants understand the different spectroscopic methods,

Learning in the Field

As part of the workshop we go out into the field and sample from sites that could be considered analogs of their exoplanets. Our sites include an acid mine drainage site, a highly organic runoff pond from a golf course, a very cold mountain spring, and an iron-rich slag pit. We collect environmental data at these sites and evaluate the habitability of these locations. We then collect samples so that we can observe the native organisms of these sites, many of which are distinctive extremophiles. Participants receive training in collecting sterile samples and culturing from environmental samples and are giving information on how to integrate a field component into their own curriculum. Participants are free to design experiments that can inform them about the range of their viability and requirements for life that may inform their mission planning for their exoplanet of interest.

Going to the Literature

Interpretation and analysis of this data is conducted primarily as an independent research activity. Facilitators try to offer interpretive information as little as possible and instead coax the participants towards resources that will help them learn the contextual meaning of the collected data. The ARG relies heavily on independent research. Participants are given instruction in library search techniques and offered assistance in finding reliable primary sources that are available to the public. While selected readings are required prior to lectures and lectures are offered daily, each class is designed to accompany a specific post-lecture experiment or activity.

How to Win at Science: Mission Proposals and Panel Review

The final project of the astrobiology ARG is a presentation of the proposed exoplanet mission to the class at large and a panel of peer reviewers made up of the workshop guest lecturers and invited faculty. Participating groups can choose a level of funding for their mission - Flagship, New Frontiers, or Discovery – with Flagship being most expensive and Discovery being the least expensive. According to the rules of the ARG panelists have only enough “money” to “fund” one Flagship mission or up to three less expensive missions. Projects are evaluated on three criteria: the validity of the scientific question, the utility of proposed methods, and the cost-effectiveness of their approach

In preparation for the final project participants are given information on the science goals of the NASA Astrobiology nstitute and the funding classes of NASA Solar System Programs. While this may seem like bureaucratic minutiae we include this in the final stage of the ARG to create an incentive for participants to learn about existing technologies in planetary exploration. Existing technology can be used at minimal costs for the proposed missions in the ARG. Groups do extensive research on the instruments already developed and become very familiar with the capabilities of currently deployed orbiters, rovers, and rocketry in a way that is informative and engaging. Using existing technology allows groups to expand their own data collection goals for their missions while requesting only funds only for new, novel tools specific to their world.

While stressful, we endeavor to make the panel reviews a very fun activity as well. To keep things interesting we include a winning category that is “people’s choice” that just considers the “cool” factor for a given mission. Panel reviews lead to very enjoyable, frank discussions about the practicalities of planetary exploration and are a vital part of the learning activity. Groups often become very invested in the peculiarities of their exoplanets and their mission proposals. By the time of the final project they are experts on their worlds. After panel review the facilitators reveal the true identity of their exoplanets and emphasize that the participants are now experts on four distinct planets of great astrobiological interest.

Outcomes and Intent

While we have embedded enormous amounts of scientific knowledge in the ARG our major goals are quite simple. We hope participants gain an appreciation for the goals of the NASA space program and realize the enriching potential of this research. We want participants to realize that project-based learning like an ARG can be a fun, creative way of teaching large amounts of material from multiple scientific disciplines if you can make the goal engaging and the experiments exciting. Most importantly, we want participants to leave with an appreciation for scientific methodology, to feel as if they have collaborated in a scientific effort, and to feel confident in their ability to design an experimental program.

In order to assess the success of a workshop all participants are asked to complete a detailed questionnaire about the content and their experience and to write a brief review. Prior to teaching through the ARG workshop reviews complained that we included too many lectures which were obtuse or impractical, with little consideration for the goals of secondary science instruction. Through the ARG we have given the lectures new meaning, as a data collection opportunity that informs the greater goal and teaches scientific methodology. 71% of ARG participants said that they found the collaborative approach to be more informative within the context of the class whereas only 40% of the participants found the material to be useful in the more traditional lecture-based curriculum.

In previous years participants had complained that the hands-on activities were merely descriptive and relied too heavily on expensive equipment or supplies that would never be accessible to secondary schools. By making experimentation and data collection part of the ARG our activities were given new utility within the game. We were also very sensitive to include only supplies and apparatus that are inexpensive and easily available and even included part numbers and ordering information from Carolina Biological and Ward’s Scientific to participants. 82%

of the participants in the ARG enjoyed the interactive, embedded design of the experiments within the context of the final project. In previous years only 45% of the participants had found the hands-on activities to be useful. ARG participants expressed a newfound appreciation for the how data is collected and how scientific knowledge is built incrementally through reflection upon previous work. By teaching the workshop as an ARG we hoped to give teachers the tools to use this same style of teaching in their own classrooms.

Our final activity is a roundtable discussion and "debriefing" where teachers are encouraged to speak openly about what portions of the workshop they found the most useful how they might implement the material introduced in the workshop. While most teachers found the format very enjoyable many expressed reservation about using the same style of instruction in their own classroom. Most participants recognized that teaching in an ARG format requires a great deal of participation on the part of the teacher as DM/GM to keep the project moving in a positive direction. Teachers recognize that this format requires a great deal of general preparation compared to the usual lecture-based system. We have tried to emphasize to the participants that using real - rather than imaginary - data sets will make the task of directing the ARG much easier and only requires good literature search skills. In addition to the roundtable discussion a small, randomly selected focus group is lead through a review by a third-party evaluator. These focus group discussions also indicated that participants were reluctant to use an ARG or really any project-based learning because it is difficult to evaluate and assign grades for this type of open-ended work. Participants were unsure if they could evaluate projects as precisely and as easily as they could exams.

While we were not able to support a longitudinal study of outcomes we have found, through casual communication, that despite the reservations expressed a minimum of 10% of participating teachers have used the ARG method for at least a portion of their curriculum. If the opportunity to continue the workshop with a follow-up study were to arise it would be useful to form two participants into two groups – one provided information on the pedagogical foundation of gameful learning and the second, like the groups discussed in this paper, unaware that they are actually participating in a role-playing game and learning through a gaming framework. As presented, we never explicitly called the workshop format an ARG but rather, referred to the format as extended inquiry-based learning. It would be interesting to see if teachers are more or less likely to use the ARG technique if they are aware that this is a game process that has been used in other curricula.

Our Success as an Epistemic Learning Environment

Shaffer (2006) identifies three key components of an epistemic learning and gaming system that teaches not just content but equips new ways of thinking;

- An epistemic game uses knowledge and/or skills from the field or environment in question
- An epistemic game teaches the player the values of the community
- An epistemic game establishes the identity of the player as a member of the community

Clearly the astrobiology ARG offers students enormous amounts of background. By formatting this large amount of information as objectives in game play knowledge acquisition becomes less onerous and takes on significance as part of a strategy. Even the very vital library and literature search skills that scientists rely on can be more interesting when the goal is a self-directed objective rather than an arbitrary assignment or report.

This ARG explicitly communicates the specific goals and contributions of the NASA Astrobiology Institute in a way that engages students in the mission of the space program by asking them to be fellow contributors. In sharing our vision of scientific research we hope we have inducted the participating teachers in the scientific values of the astrobiology community. More generally, by sharing the complexities of scientific methodology we invite them to participate as more informed consumers of science and hope they become engaged in the values of scientific research as a whole.

One of the most important goals of the workshop was to be sure that teachers understand that they are valuable members of the scientific community given that they are actively preparing future researchers. We emphasize the funding structure of NASA missions so that teachers understand that greater than 90% of the budget of any major mission goes towards scientists and engineers. Human capital is the greatest strength in science and our success relies on inspired, well-prepared students that are ready to meet future research challenges.

Our epistemic gaming ARG approach offers sound science training and emphasizes collaboration and recognition of interdisciplinary work. Our design is able to engage students in learning large amounts of data that would otherwise be rather boring rote memorization and also makes mundane tasks such as literature search into a goal-oriented activity. By requiring students to employ the scientific method not as an arcane five-step process but as an organized way of asking questions and producing data the ARG is able to demonstrate scientific methodology in an exciting context of self-determination and discovery.

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Revealing how a videogame can change players' implicit racial biases

Belinda Gutierrez, Dennis Ramirez, Sarah Chu, Clem Samson-Samuel, Molly Carnes,
University of Wisconsin-Madison
bgutierrez@wisc.edu, dennispr@gmail.com, sarahnchu@gmail.com, cgsamuel@wisc.edu, mlcarnes@cwhr.wisc.edu

Abstract: African American men are underrepresented among faculty in academic science, technology, engineering, mathematics, and medicine (STEMM). Implicit racial biases are one factor that may contribute to this underrepresentation. The current study examines whether a videogame can reduce implicit racial bias, inducing players to feel empathy for the game's protagonist, an African American graduate student named Jamal Davis. Participants in this randomized controlled study either played a game designed to reduce implicit bias (experimental condition) or read a narrative based on the game experience (control condition). In both conditions, the participants are asked to take on the role of Jamal; however, in the game, players actively get to play as this character. Participants' levels of perspective taking and empathy for Jamal, awareness and experience of bias, and implicit bias towards African Americans were compared to understand whether gameplay can lead to reductions in implicit racial bias.

Introduction & Context of the Study

African Americans make up thirteen percent of the U.S. Population (U.S. Census, 2010), but only four percent of faculty in science and engineering at all four year colleges and institutions (NSF, 2008) and only three percent of faculty at Research I institutions. There are numerous reasons for this underrepresentation. Popular explanations include: inadequate science, technology, engineering, mathematics and medicine (STEMM) exposure in K-12; negative peer pressure; low expectations from teachers; students' belief in stereotypes about what science is, what scientists do, and what kinds of people become scientists, (Quality Education for Minorities Network, 2010). Another factor that has been studied to a lesser extent is implicit racial bias of current STEMM faculty members.

Implicit biases are unconscious assumptions based on group stereotypes. Implicit racial bias is an unconscious tendency to prefer one race of individuals to another. Studies show that the majority of people in the U.S., including individuals in STEMM fields such as medicine (Green et al., 2007) and psychology (Boysen & Vogel, 2008), unconsciously prefer White individuals to Black individuals (see also Nosek et al., 2007; Nosek, Banaji & Greenwald, 2002).

The majority of people in Western societies also have stronger implicit associations with men and science than with women and science (Nosek, Banaji, & Greenwald, 2002; Cvencek, Meltzoff, & Greenwald, 2010). In other words, most individuals hold the stereotype that most scientists are men. Studies have shown that when the majority of individuals in a given culture have high implicit biases against women in science, women have lower science and math achievement (Nosek et al., 2009). Thus, implicit biases, even though unintentional, can disadvantage individuals from negatively stereotyped groups.

Not a single study directly measures the impact of implicit racial bias in academia; however, numerous studies document the "chilly climate" and subtle racial discrimination that racial/ethnic minority faculty experience (e.g., Solorzano, Ceja, & Yosso, 2000; Peterson, Friedman, Ash, Franco, & Carr, 2004; Pololi, Cooper, & Carr, 2010; Singh, Robinson, & Williams-Green, 1995). While most individuals do not believe themselves to be racist, it is possible for explicitly non-prejudiced individuals, with the best intentions, to act on implicit racial biases (Devine, 1989).

In academic medicine, Black faculty are one third as likely to hold senior rank as White faculty, even after statistically controlling for department, medical school, years as faculty, number of peer-reviewed publications, receipt of research grant funding, proportion of time in clinical activities, sex, and tenure status (Palepu, Carr, Friedman, & Ash, 2000). Black STEMM faculty are also ten percent less likely than White faculty to receive a National Institutes of Health (NIH) R01 grant, even when controlling for demographic variables (e.g., race/ethnicity, gender, citizenship status), education and training (e.g., degree type, degree field, previous NIH training), employer characteristics (e.g., NIH funding rank, institution type, Carnegie Classification), NIH experience (e.g., previous NIH grant awards, NIH review committee member), and research productivity (e.g., publication quartiles, citation quartiles, impact factor of publications; Ginther, et al, 2011). On the website ratemyprofessors.com, Black male faculty are rated more negatively by their students than all other faculty (Reid, 2010). Thus, it is possible that unconscious racial biases impact the careers of African American faculty.

Research has found that taking the cognitive perspective of an individual from a stigmatized group can reduce one's implicit bias. A recent study (Todd, Bodenhausen, Richeson, & Galinsky, 2011) found that implicit bias towards African American men was reduced when individuals attempted to take on the perspective of an African American man being discriminated against. Another study found that non-Muslim participants who simply imagined talking to a Muslim stranger showed decreased implicit bias towards Muslims (Turner & Crisp, 2010). One caveat to this work is that individuals are more likely to take the perspective of those believed to have similar personality characteristics and values (Krebs, 1975).

Typically, perspective-taking studies ask participants to read a narrative, or listen to an interview, and then imagine themselves as the individual. Yet, what if participants were able to actively take on the role of such an individual? Would this lead to improved results? Few studies have considered this type of "active perspective taking," however, one such study (Clore & Jeffery, 1972) asked a group of able-bodied college students to spend 25 minutes traveling around campus in a wheelchair. They asked another group of able-bodied students to follow them at a close distance. They found that both students who traveled in a wheelchair and those who followed them responded significantly more positively to a disabled person. Additionally, four months later, they were more likely to recommend increased university spending on facilities for disabled students. This study was conducted before the development of measures of implicit attitudes, such as the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998). The current study asked participants to actively take on the role of a member of a stigmatized group, in this case an African American scientist, to determine whether spending a day in his life will lead them to take his perspective, and in turn, have decreased implicit bias against all African Americans.

Videogames are a unique medium in which players become immersed in virtual worlds that would otherwise be difficult to replicate (Gee, 2003). Players are active agents in these game environments, and interactions therein can result in memorable and personal experiences for the players (Squire, 2011). Player engagement is a key consideration in game design, and many designers strive to create worlds in which players will identify and empathize with the main character of the game (Schell, 2008). Good games allow players to merge their real-world identity with the identity of their game character, typically the protagonist.

Games allow for vast opportunities to role-play, thus, lending themselves to opportunities for active, or embodied perspective taking. Yee and Bailenson (2006) found that college students who actively took on the perspective of an elderly person in a virtual environment developed more empathy and positive attitudes towards the elderly than students who took on the perspective on a young person. The purpose of the current study is to examine whether playing a videogame in the role of a member of a stigmatized group will lead to greater reductions in implicit racial bias compared to simply imagining oneself in that role. To this end, we have designed a videogame in which players play a young African American graduate student named Jamal Davis. We conducted a randomized controlled study in which we compared playing Jamal in the videogame *Fair Play* (experimental condition) to reading a narrative description of the events in the game (control condition).

In *Fair Play*, we capitalize on players' projected identity (Gee, 2003) to create experiences where they can actively take on the role of Jamal. In the game, Jamal experiences subtle racial discrimination from his colleagues and, as the game goes on, players are encouraged to imagine themselves as Jamal and reflect on the impact of the non-player characters' (NPCs) implicit racial biases.

Methods

We collected data from 131 graduate students from STEMM departments at a large university in the Midwest. Participants were recruited to participate in the study via email invitation. The email included a link that randomly redirected participants to either the experimental or control condition.

The experimental condition contained the game described above, in which participants played the role of Jamal as he navigates through the world of academia. In the game, participants had the opportunity to experience implicit biases as Jamal, particularly in his encounters with other game characters and environment. The control condition contained an image of Jamal and a narrative of the experiences he encounters throughout the game, though this narrative does not allude to the game directly. Participants in both conditions were asked to "imagine (themselves) as Jamal." This phrase has been found to be a useful way to induce perspective taking in previous studies (e.g. Batson, Early, & Salvarani, 1997; Todd, Bodenhausen, Richeson, & Galinsky, 2011; Turner & Crisp, 2010).

Participants in both experimental and control groups were given the same seven outcome measures immediately after playing the game or reading the narrative. First, they took an Evaluative Race Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998), which quantified the strength of their implicit racial associations. Next, they completed a brief survey battery containing a measure of empathy (Batson, Early, & Salvarani, 1997; Batson, Polycarpou et al., 1997; Toi & Batson, 1982) and three questionnaires designed by our research team to measure: level of engagement in the exercise, degree of perspective taking, and awareness of racial bias that occurred in the exercise. Players also provided brief qualitative responses to questions about player identity and what they learned during the exercise. Finally, players answered demographic questions such as previous videogame experience, gender, age, and academic college or school.

Results

128 individuals completed all outcome measures. There were 70 (53%) participants in the control group and 58 (44%) in the experimental group. Forty-seven percent (N = 63) were male and forty-six percent (N = 62) were female (3 participants chose not to respond). Seventy-six percent (N = 99) identified as “White” and thirty-six percent identified as non-White (N = 47; 4 African Americans, 13 Latinos, 21 Asians, and 1 American Indian). Finally, twenty percent self-identified as gamers (N = 13) and seventy-nine percent identified as non-gamers (N = 103).

All scales had good internal consistency with the exception of perception of bias; Cronbach’s alphas were: level of engagement scale (.821), perspective taking (.892), perception of bias (.521), and empathy (.951). As internal consistency for the perception of bias scale was poor, it was not used for further quantitative analyses. Due to the fact that the majority of participants identified as White/Caucasian, implicit bias is only reported for those individuals. With the exception of implicit bias, all scales had non-normal distributions, thus non-parametric statistics were used for the majority of analyses.

There was no significance in participants’ level of implicit bias in the experimental (M = .30, SD = .33) versus control (M = .29, SD = .40, t(96) = .13, p = .93) groups. However, participants in both conditions had lower levels of implicit bias than the survey data would suggest. Nosek et al. (2007) found that individuals across the country have higher implicit bias scores than participants of our study (M = .37, SD = .43). Sabin, Nosek, Greenwald, and Rivera (2009) found slightly higher levels of implicit bias among individuals with doctorates than our sample (M = .32, SD = .45).

Mann Whitney U tests revealed no significant differences in engagement (experimental Md = 10.0, n = 58; control Md = 10.0, n = 69; U = 1984, z = -.080, p = .94), or perspective taking (experimental Md = 16.0, n = 58; control Md = 17.0, n = 68; U = 1748, z = -1.11, p = .267). Level of empathy for Jamal was significantly different for the experimental (Md = 19.5, n = 56) and control conditions (Md = 28, n = 63; U = 1209, z = -2.96, p = .003, r = -.27), with participants in the control condition (website) reporting more empathy for Jamal.

A one way between groups multivariate analysis of variance was performed to investigate sex differences in identification with Jamal. Two dependent variables were used: perspective taking and empathy. The independent variable was gender. There was a statistically significant difference between males and females on those combined variables (F (2,118) = 9.79, p = .000; Wilks’ Lambda = .86; partial eta squared = .14). When considered separately, there were significant differences in perspective taking (F (1,121) = 17.59, p = .000, partial eta squared = .13) and empathy (F (1,121) = 9.53, p = .003, partial eta squared = .074). An inspection of the mean scores indicated that females (M = 17.22, SD = 2.67) reported more perspective taking than males (M = 14,63, SD = 3.96). Females (M = 26.3, SD = 10.39) also reported more empathy for Jamal than males (M = 20.59, SD = 9.97).

A separate one way between groups multivariate analysis of variance was performed to investigate race/ethnicity differences in identification with Jamal. Two dependent variables were used: perspective taking and empathy. The independent variable was race/ethnicity. There was a statistically significant difference between individuals who identified their race as White compared to those who identified as non-White (F (2,188) = 4.22, p = .017; Wilk’s Lambda = .93; partial eta squared = .07). When results for the dependent variables were considered separately, only empathy was statistically significant (F (2,119) = 8.11; p = .005; partial eta squared = .07). An inspection of the mean scores indicated that White participants reported more empathy for Jamal (M = 24.70, SD = 10.31) than non-White participants (M = 17.96, SD = 9.86).

Discussion and Implications

This is the first study of a videogame that uses perspective taking to reduce implicit bias against African Americans. We did not find that the videogame lead to decreased implicit bias compared to our control condition; however, we did find slightly reduced levels of implicit bias compared to other studies. Thus, it is possible that either playing the game or viewing the website lead to reduced implicit bias for participants in this study. Future studies should incorporate a pre-test/post-test methodology to determine whether the website or game conditions directly lead to reductions in implicit bias.

Interestingly, participants in the control condition reported more empathy for Jamal than those who played the game. One explanation for this is that *Fair Play* was designed to immerse the player as Jamal. Because empathy is the capacity to recognize the emotions in others, it would be difficult for players to experience empathy for a character designed to be an extension of them. In fact, several participants self-reported that it is difficult to have empathy for yourself, suggesting that they saw Jamal as an extension of themselves. This suggests that empathy may not be a compelling measure to study players using games that foster projected identity, unless the players' empathy for other non-player characters is of key interest. Future studies should explore additional factors that lead readers of the website to report more empathy for Jamal.

Female participants reported more perspective taking and empathy for Jamal and White participants reported more empathy for Jamal. Future studies should examine the specific factors that lead to this difference. Future studies should also include more racial/ethnic minority participants so that differences among minority groups can be unraveled.

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The Narrative Potential of Tabletop Role-Playing Games

W. Trent Hergenrader, University of Wisconsin-Milwaukee, trent.hergenrader@gmail.com

Abstract: This paper discusses the unique way tabletop role-playing games generate stories for their players, and how creative writing instructors may use these methods to teach fiction writing techniques to beginning writers. The author explains his theory of incremental storytelling, a methodology by which role-playing games provide an ideal model for students to learn the craft of fiction writing in small, discrete bits that, in aggregate, create something much greater than their constituent parts. This progressive approach puts students in immediate contact with each others' writing throughout the entire creative process and opens space for critical discussions about the fictional characters and the shared world they create.

Gaming the Creative Writing Classroom

College-level creative writing classes tend to be taught using the workshop method. In brief this typically means the instructor circulates a published short story or two that students read and critique, which is followed by students writing and submitting their own work. This student writing is distributed to the class and is likewise critiqued based on various elements of craft: character, plot, setting, POV, theme, and tone. Yet using this approach in my first years teaching, I found myself being frustrated by what I perceived as an overall lack of student engagement with the course material, including the readings, the written assignments, and especially a lack of interest in each other's work. Another serious roadblock was many students' overriding obsession to pin down a singular meaning of what a creative piece meant before it could be studied or even appreciated. I've since called this the "buried treasure approach to literature," which is a belief that authors bury deep meaning beneath layers of symbols and metaphors that an educated reader learns to dig up. Noted American poet Ron Silliman (2008) has made a similar observation in his blog, speculating that from K-12, students are taught "that language is to be mined for 'information' that can be later regurgitated in test formats," and thus novice writers take a similar meaning-heavy approach to their writing poetry or fiction at the expense of craft issues.

To counteract this I first experimented with Surrealist parlor games and OuLiPo constrained writing techniques to mitigate students' strong impulse to focus only on meaning. While such games focus attention on language use, they do little for teaching other elements of craft such as characterization and setting, and they still did not bring the class together as a writing community. I wanted to shift the goal of my creative writing classes away from literary production and toward a model that favored collaborative writing, digital production, and a more student-centered classroom. To those ends, I adopted a different type of game, one that captured my imagination as a teenager: the role-playing game (RPG).

RPGs as Catalogs of Fictional Worlds

While it might be an unusual concept for teaching a fiction course, using RPGs to provide an engaging storyline is nothing new, especially among writers of genre fiction. George R. R. Martin, author of the wildly popular *Game of Thrones*, hosted a long-running superhero RPG campaign for other successful genre writers who used them as an impetus for the long-running *Wild Card* series, which currently includes over twenty books. In an interview, writer China Miéville (Gordon, 2003), author of multiple novels including the award-winning Bas-Lag trilogy set in and around the sprawling city of New Crobuzon, said that he credits RPG's "mania for cataloguing the fantastic" as an influence for the many maps, histories, and timelines he creates that give him a firm grasp on his fictional world, even if all of these details never make it into his novels. Miéville's comments speak directly to the appeal of RPGs for players with their virtually endless catalog of locations, characters, and items that can be combined and recombined in an infinite chain of stories.

Catalog is the operative word, with its connotations of skimming and selecting of desired items, each with its own unique properties and descriptions. RPG rulebooks dedicate whole chapters to different game categories, such as character creation, weapons and armor, map making, modes of transportation, spells, etc. and well-established games like *Dungeons & Dragons* publish multiple *volumes*, giving players a vast reservoir of information to draw from when shaping their games. And yet no single catalog entry is a story unto itself. While a magic sword may have an elaborate history in its description, its function in the game is not to be a story for its own sake but to provide a platform for original storytelling by the players. They are the pieces from which the RPG narrative is assembled.

This construction metaphor is echoed in Daniel Mackay's (2001) book *The Fantasy Role-Playing Game: A New Performing Art*, where he says players use "fictive blocks" of "famous lines, quotable postures, and vivid traces from literary passages or film scenes" (p. 77) that are "restored as strips of imaginary behavior that constitute the role-playing performance from moment to moment" (p. 80). Players bring their own knowledge and memories to the games and customize them to their tastes by altering rules and adding new elements, and they are able to resist and recoup the consumerist nature of popular culture, Mackay writes,

Because the form of the game encourages the players to bring their affective selves, their subjective selves, to the table and to winnow the concepts and images of our environment through that subjectivity… [to] fill in the blanks of popular culture… through his own emotional involvement with the role… [which is] predicated upon interaction with other people. (p. 82)

Through role-playing, players gain agency over the pop culture tropes of genre fiction—as cataloged in novels, comics, films, and videogames—by having near-complete control over their characters and the game world, save whatever control they willingly cede to their immediate gaming group in return for deeper investment in the game.

The fictive blocks and genre conventions Mackay describes exist across media, yet we still may critically analyze and make connections between them. Ian Bogost (2006) proposes a methodology whereby any medium can be understood as a configurative system of discrete, interlocking units of meaning-making called *unit operations*. Bogost describes unit operations as "modes of meaning-making that privilege discrete, disconnected actions over deterministic, progressive systems" (p. 3) as opposed to system operations, which are "totalizing structures that seek to explicate a phenomenon, behavior, or state in its entirety" (p. 6). To apply Bogost's theory to creative writing, students exhibiting a tendency to read a print text searching for a fixed immutable "meaning" could be said to be examining systems operations, looking for clues that would reveal the totalizing structure that serves to inform a correct interpretation of the work. Unit operations, however, isolate discrete moments of meaning-making in a text that invite the exploration of alternate configurations. Where systems suggest rigidity and determinism, units suggest fluidity and potentiality in narratives. Combined with Mackay's concept of fictive blocks, we can understand RPG genre settings not as a tired set of clichés but rather stored and highly configurable units of fictive meaning, drawn either from a catalog or from memory, which can be appended or altered based on the subjective interests of the player during the process of constructing a unique narrative.

Although using RPGs in writing classes might seem unorthodox, in fact fiction writers have long used isolated writing exercises as a way to hone their craft. In John Gardner's (1983) influential *Art of Fiction: Notes on Craft for Young Writers*, he suggests students work on small, discrete exercises that may grow into something else:

> I would begin, then, with something real—smaller than a short story, tale, yarn, sketch—and something primary, not secondary (not parody, for example, but the thing itself). I would begin with some one of those necessary parts of larger forms, some single element that, if brilliantly done, might naturally become the trigger of a larger work-some small exercise in technique, if you like, as long as it's remembered that we do not really mean it as an exercise but mean it as a possible beginning of some magnificent work of art. A one-page passage of description, for example; description keyed to some particular genre-since description in a short story does not work in the same way description works in the traditional tale. And I would make the chief concern of this small exercise the writer's discovery of the full meaning of fiction's elements. (p. 35)

Gardner speaks of the craft exercise that is not a throwaway gimmick but rather a seed than can germinate into something much grander. When put into the context of a large-scale collaborative writing project, no small exercise in technique would be wasted at all as the deftly crafted piece adds to a "magnificent work of art" where every contribution adds to a greater, more diverse catalog from which all contributing writers may draw.

Incremental Storytelling: The Collaborative Creation of a Vast Fictional World

These different aspects of the catalog form the basis for my theory of teaching fiction writing using RPGs as models, a methodology I'm calling *incremental storytelling*. Rather than assuming all writers are prepared to write fiction that balances multiple craft issues simultaneously, incremental storytelling breaks these craft issues into discrete exercises that, over time and through collaborative effort, will aggregate into something much larger and complex than any individual could produce, and gives students a unique perspective on the elements of fiction writing. To cast it in different terms, incremental storytelling is a move from the macro element of story to the microelements of craft. As writers, we gain a better understanding of the city by first understanding a single house; we reach a better understanding of our characters by first detailing their individual traits; and we tell better stories after experiencing characters' reactions to unforeseen challenges. This is the craft of fiction writing broken into units of meaning.

Thus the RPG provides an excellent structure for creating space for a digital, collaborative, student-centered writing project. Rather than using a store-bought RPG, an instructor can choose from several game mechanics—the basic stats and manner by which game conflicts are resolved (dice, cards, etc.)—and put the students to work creating the world incrementally using a wiki. Instead of the traditional workshop method of dissecting published stories for the study of characterization, setting, and plot, one can adopt a reverse strategy and begin instead with fragments; rather than struggling to pull student writers away with their obsession with a published story's meaning, you start with individually crafted objects that draw from a genre knowledge gathered across media, which then become the building blocks of the fictional world.

In the following sections I will briefly discuss how using RPGs and incremental storytelling can be used to teach three key elements of narrative—setting, character, and plot—and help beginning writers become more attuned to the micro elements of fiction writing.

Setting

RPGs and fiction alike must be set in an explicit geographic location and historical period, whether on ancient Earth or in some distant galaxy far in the future. The setting and rules of the world dictate what will and will not be possible in the characters' unfolding narratives.

Writer and scholar Peter Turchi's (2004) *Maps of the Imagination: The Writer as Cartographer* is an extended metaphor, comparing mapmaking with the creative writing process, a filling in of white space with content, whether with words and sentences or geographic details. Like Miéville, Turchi argues that rather than merely telling "what's there" in a story, writers must be able to imagine a full and vibrant world full of narrative potential, even if many of the details never make it to the page. Though few beginning writers may recognize it as such, choosing a setting is also an inherently political act. Turchi explains:

We chart our cities, so we chart ourselves. To chart the external world is to reveal ourselves—our priorities, our interests, our desires, our fears, our biases. We believe we're mapping our knowledge, but in fact we're mapping what we want—and what we want others—to believe. In this way, every map is a reflection of the individual or group that creates it. By "reading" a map, by studying it, we share, however temporarily those beliefs. (p. 146)

The presentation of the world, whether in maps or in prose, hinges on the authors inclusions and omissions of specific details; for example, by omitting Native American tribal areas (Turchi, 2004) and presenting Africa as a blank slate for the projection of European fantasies (McHale, 1987), European mapmakers indeed inscribed their culture's priorities, interests, desires, fears, and biases, a phenomenon replicated in the literature of European colonialism and American westward expansion. Such gross oversights took hundreds of years to be recognized and (marginally) redressed, yet when it comes to the mapping of fictional worlds, creative writing instructors are poised to intervene at the moment of production through what Mayers (2005) calls "craft criticism," or the analysis of the social, political and institutional context at play in the construction of an artistic work.

In the context of collaborative world building in an RPG-inspired creative writing course, instructors may note such omissions and ask the student writers to reflect upon and discuss these absences, and then correct them. Another strategy is to highlight the tensions that arise naturally from the clash of artistic perspectives in a room populated with students of different genders, races, social classes, and sexual orientations. In a traditional writing workshop such concerns may be mentally partitioned as something unique to a single writer or story, a special issue that must only be coped with by female or ethnic writers for example; however in collaborative world building, the various narrative units reside on the same plane. Writers must contend with the social concerns of others in their own creative work, something few beginning writers will have faced. The result is a catalog that suggests an uneven, messy world full of contradictions and curiosities—in other words, something much more resembling our real world than most neatly manicured fictional settings often seen in undergraduate creative writing classes.

RPG worlds are nothing if not vast and diverse. As Jennifer Growling Cover (2010) states in *The Creation of Narrative in Tabletop Role-Playing Games*, expansive RPGs are designed not to tell stories, but to create space for stories, echoing Henry Jenkins' (2004) claim that game designers are less authors of stories and more providers of evocative spaces rich with narrative potential that allow players to perform or witness narrative events, and that literary genres of such as fantasy adventure are particularly invested in world-making and spatial storytelling. Thus the fictional worlds created for RPGs provide infinite space for the game narrative to grow and be shaped by the players. Players become story-builders as their interactions with the fictional world leave discernable traces on the game space (Fernandez-Vara, 2012), itself a kind of authorship occurring in an ongoing, recursive process that increases the sense immersion in the fictional world for players and adds to their enjoyment of the game (Cover, 2010). More than just traversing a world, players in RPGs choose which storytelling invitations to accept and, in doing so, leave their own mark on the world.

The setting of most RPGs usually belongs to one of the popular literary or cinematic genres: fantasy, science fiction, horror, espionage, or superhero worlds (Mackay, 2001). Rather than this being a detriment it is in fact a benefit, as it opens a critical space discusses differences between our perceptions of reality and the “reality” of the shared fantasy world. In a collaboratively built fantasy or science fiction world, even mundane details must be agreed upon by the writers. Not only do these genres require writers to interrogate some of their unconscious assumptions when building a fictional world, these different genres allow player/writers to explore various timeless themes present in mythology, or explore relationships between humans and technology (Bowman, 2010).

As discussed earlier with respect to Mackay’s fictive blocks, another benefit of using popular genres is the wealth of material across media from which students may sample. Unique features, details, and rules of fictional worlds can be drawn from literature, films, comic books, and games, media that most students will be more familiar with than work being published in contemporary literary journals.

The creation of this vast world takes happens incrementally through small, concise writing assignments. Even the metanarrative of the world, such as notable historical events as well as the general economic, social, and political systems (or lack thereof) that provide structure for the inhabitants of the world need to be grounded in specific, isolated details, events, and rules in order for them to be incorporated into game play. Though the world will continue to grow and shift during the course of play as players leave their unique traces upon it, the next step is to place actors on this intricately designed stage.

Characters

Well-rounded, interesting characters are crucial for the success of fiction and RPGs alike. For Gardner (1983), the fiction writer’s chief goal is to “make up convincing human beings and create for them basic situations and actions by means of which they come to know themselves and reveal themselves to the reader” (p. 14-15). Flannery O’Connor (1969) encouraged novice writers to devote ample time to their characters, who should naturally drive the story’s plot:

> In most good stories it is the character’s personality that creates the action of the story. In most [workshop stories], I feel that the writer has thought up some action and then scrounged up a character to perform it. You will usually be more successful if you start the other way around. If you start with a real personality, a real character, then something is bound to happen; and you don’t have to know what before you begin. In fact, it may be better if you don’t know what before you begin. You ought to be able to discover something from your stories. If you don’t probably nobody else will. (p. 105-6)

For Gardner and O’Connor, the act of reading and writing fiction should be one of exploration and discovery on part of the reader, writer, and even the fictional characters themselves. The question for students writing fiction ceases to be “what do I want my story to mean?” but rather “who is my protagonist and what are his or her unique qualities?” This is precisely the same question facing a player starting a new RPG campaign.

In terms of shaping a narrative from an RPG, character creation is a moment where players have most control over the game (Cover, 2010). Players create their characters incrementally, determining their traits and abilities based on the game rules, which often use a system of numerical representation. For example, characters in *Dungeons & Dragons* have statistical categories such as strength, wisdom, and dexterity and the scores range from 3-18 based on the rolling of three, six-sided dice the player rolled for each category when generating the character. Other games, such as those that use White Wolf’s *World of Darkness* d10 system, require players to distribute a fixed number of “dots” across multiple categories, with the dots representing how many dice will be rolled when players attempt certain actions. Both systems give players a tremendous amount of flexibility when designing their characters, and RPG systems are careful to ensure characters have strengths and weaknesses. The GM refers to these statistics when resolving challenges in a game; for example, a character’s agility score may be used to see if a character can scale a drainpipe to a rooftop, or their charisma score may come into play if the character is attempting to fast talk his or her way out of a tight situation.

Players often use archetypal figures when developing the statistics of their RPG characters (Bowman, 2010) such as the warrior possessing more brawn than brain, or the thief who prefers stealth to physical confrontations. The former character type would typically have high scores for strength and combat skills, while the latter type would have a higher speed and dexterity. As the player determines each trait, a mental picture of the character becomes clearer. Even if the player has a firm concept of the archetype they wish to work with—warrior or thief for example—this generalized idea becomes specific and unique through incremental adjustments made by the player.

However, as Mackay (2001) notes, these "numerical quantifications of abilities…only quantify elements that are secondary to the story, leaving the primary elements of theme, meaning, and character development unbounded by the rules" (p. 47). Thus players almost always create personal histories, often quite elaborate ones, to further flesh out their characters: where they come from, their family situation, their beliefs and attitudes, how they acquired their skills, their short-term and long-term goals, habits, pet peeves, etc. These details are crucial since the character is point of contact between the player and the fictional world; in other words, how the player crafts the character will strongly determine how the character will interact with the fictional world—what roads she will travel, how she will interact with others, what situations will she choose to get involved with, and which she will pass by (Mackay, 2001). A lawful character may choose to join up with a band setting out to disband a thieves' guild; the unscrupulous character may try to warn the guild in hopes of procuring a reward. The player must have a keen sense of who his character is in order to have an enjoyable role-playing campaign.

The questions players address during the character creation phase strongly resemble creative writing exercises meant to help fiction writers develop realistic characters. In *What If?: Writing Exercises for Fiction Writers*, Bernays and Painter (2010) have two chapters and seventeen exercises geared toward helping fiction writers learn more about their characters. "Fictional characters don't come equipped with clues," they write. "You, as writer, must supply them. The more specific your make these clues, the more immediate your character will be" (p. 31). The exercises require writers to list traits such as their characters obsessions, politics, ambitions, as well as give them concrete details such as their careers as well as more intangible qualities such as their motivations and wants. They add:

Beginning writers often don't know more than a character's age or gender—and frequently neglect an essential piece of information that would have greatly informed or shaped their story. You needn't include these details in the story, but their presence in your mind will be "felt" by the reader. (p. 39)

Bernays and Painter quote authors such as Ernest Hemingway, F. Scott Fitzgerald, and Graham Greene to emphasize the importance of writers knowing as much about their characters as possible since such details may be important for the story being written. Deeply knowing their characters is even more pertinent for players of RPGs, who will have limited control over the direction of the game narrative and thus cannot predict when such details will need to be summoned. While a fiction writer can add new wrinkles to a character's personality over multiple rewrites, during a live-action RPG session the player has no such luxury. Absent details equate to missed narrative opportunities in the game world, so players often write copious notes about their characters' attitudes, beliefs, idiosyncrasies, and personal histories.

Bowman (2010) also argues that RPGs "force players to begin to think about their character as a layered, multi-faceted being" at the moment of character creation that allows players to identify with someone "other" than themselves:

> Just as when reading a book or watching a film, role-players must inhabit a different head space and identify with someone "other" than themselves. RPGs push this identification a step further, allowing that "other person" to evolve as the player's own creation, rather than a conceptualization by an author foisted upon the passive reader of a book. (ch. 3, sec. 2)

This point strongly supports using incremental storytelling to teach the craft of developing fully realized characters to beginning writers. When writers in traditional workshops study a published story they may indeed learn to identify with the main characters but this is a second-hand analysis that occludes the fact that authors usually need multiple rewrites to sufficiently develop the character. The traditional approach often proves helpful for those writers who already have a deep understanding of their fictional characters, but it does little for those writers who only have a hazy notion of who their characters even are. Using the detailed character creation process of a sophisticated RPG, players have a vested interest in working through these details, and then they learn more about identifying with fictional characters when they inhabit the same "head space" through role-playing. Because players do not control the entire narrative, they may also focus more on their player characters, thinking deeply about how they would react to the situations and circumstances they did not expect. Free from the burden of plot, players instead focus on how their characters perceive events, reflect on their personal histories, and evolve over time.

Plot

The creation of a role-playing narrative is a collaborative effort by necessity. Before any RPG session can begin, four components are required: a fictional world for the action to take place, at least one (though usually more) player-character (PC) with some set of motivations, a set of rules to determine the successes and failures of attempted actions, and a GM who manages the interactions between player-characters and the fictional world. The ensuing story develops through the GM describing the fictional world, listening to how the player-characters react to the situations, and determining the outcome, which may or may not require an appeal to the game mechanic such as dice rolls. The story is a result of fluid interaction between players and the GM.

This litany of choices models how beginning fiction writers should think about the multitude of options open to their characters when writing stories. Rather than dragging their characters to some predetermined outcome, beginning writers will benefit from considering the open-endedness of any given situation in the RPG. In addition, as Cover (2010) notes, dice rolls contribute to whether a character can proceed down their chosen path, and the storyline is always negotiated by the other players, each of whom can pursue different choices and consequences. Whereas a beginning writer can struggle with fully developing one character much less two or three, the collaborative nature of the RPG reduces this pressure as each players develop his or her own character. Players frequently debate how each other's characters would act and even challenge their decisions, with players commonly asking each other, "Would your character really do that?" (Cover, 2010). Because the game cannot proceed until decisions have been made and challenges resolved, there is a subtle social pressure to produce a mutually agreed-upon narrative that can prevent players from making absurd choices, which would spoil the session for all (Mackay, 2010). Conflicts between characters at key moments also provide good fodder for writing, as players may channel their frustrations and disappointments into their fiction.

Conclusion

Teachers of creative writing have much to gain by structuring fiction writing courses around an RPG, having students build a vast fictional world complete with people, places and thing through the process I call incremental storytelling. This methodology puts students in immediate contact with each others' writing throughout the entire creative process and opens space for critical discussions about the fictional characters and the shared world they create. Furthermore, this methodology undercuts students' impulse to have plot and meaning dictate their writing. A player of an RPG cannot decide on a rags-to-riches plot arc and make it so. Just as in life, a player may choose to pursue a goal for the character, but ultimately he or she has limited control in achieving it. Stories derived from role-playing campaigns are more likely to deal with a character's frustrations, sense of loss, and changing expectations, as opposed to workshop stories where beginning writers often put trivial challenges, if any challenges at all, before their protagonists. Playing an RPG through the eyes of a intricately detailed character as she makes decisions, scores unlikely victories, and suffers disappointing setbacks becomes a process of discovery about both the character and the world as the plot unfolds in unexpected ways through play. This process of discovery is exactly what traditional fiction writers Gardner and O'Connor state is at the core of good fiction. In short, the RPG provides students and instructors a rich model for producing complex and compelling narratives featuring interesting characters and immersive worlds.

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Participatory Assessment: A Game Design Model for Impacting Engagement, Understanding, and (as Necessary) Achievement

Daniel T. Hickey, Indiana University, dthickey@indiana.edu

Abstract: Participatory Assessment is a game design model for obtaining diverse learning and/or social outcomes in innovative learning environments. It fosters participation in socio-technological interactions that ensures individual understanding of targeted concepts. As necessary, the model has also been capable of improving and documenting the impact of aggregated achievement. The model emerged from assessment-oriented design studies in several environments, including the Quest Atlantis 3-D virtual environment. This paper introduces the five general design principles that make up Participatory Assessment, along with the more specific design principles that emerged across given design cycles of the Taiga game in Quest Atlantis. Specific game features are summarized, along with evidence of the impact of those features in the Taiga design studies.

Designing games for impact often forces the choice between (a) more direct "expository" approaches, (b) more constructivist "inquiry-oriented" approaches, or (c) more sociocultural "situated" approaches. This paper introduces an assessment-oriented game design model that is intended to address core tensions that emerge when designing, using, and evaluating video games to attain educational and/or social impact. This model is called *Participatory Assessment.* The model consists of five general design principles that emerged in design studies in innovative learning contexts. This paper describes these principles as they emerged in studies of the *Taiga* educational video game in *Quest Atlantis*.

Reconciling Competing Approaches to Games for Impact

Early text-based games like *PLATO* and PC games like *MathBlaster* provide "drill & practice" of specific factual and procedural knowledge. These "expository" approaches expose players to numerous specific associations. A new generation of games like *Dimension M* embeds drill and practice in mathematics into complex immersive games. Critics point out that in most drill and practice games, the relationship between the game activity and the academic content is arbitrary. While this use of extrinsic rewards simplifies game design, any learning regarding the structure, rules, or story of the game itself does not reinforce or enhance the academic content (Rieber, 2005). Furthermore, extrinsic rewards have been shown in hundreds of studies to diminish subsequent interest and engagement (Lepper & Hodell, 1989).

The "cognitive revolution" of the 1970s led to video games that embraced constructivist theories of learning and intrinsically motivated learning. LOGO and *Zoombinis* emphasized intrinsically rewarding activities that called on fantasy and curiosity, while avoiding lower-level content and extrinsically rewarded activity (Lepper & Malone, 1987). More recently, *Spore* and *World of Goo* are presumed to build critical thinking skills and deep conceptual knowledge (Kafai, 2006). But constructivist and constructionist innovators have traditionally been hard-pressed to show educational impact (Egenfeldt-Nelson, 2006).

A third wave of innovation reflects newer situative theories of cognition (e.g., Greeno, 1998) that focus on learning as successful interaction with social, technological, and informational resources. An intriguing possibility of massive multiplayer games is that they can support specific types of social interaction that lead to broader social learning of academic knowledge, as well as the more salient and readily measured individual knowledge. In this way, players can confront formal concepts and abstract principles while solving real problems (Shaffer, Squire, Halverson, & Gee, 2005). This allows learners to directly interact with complex social systems that are otherwise inaccessible to them (Squire, 2003).

The options offered by these different views introduce tensions in game design. The tensions between expository and constructivist approaches are particularly problematic. They are premised on assumptions about individual learning that are ultimately antithetical (Case, 1996). Situative perspectives introduce additional tensions because they focus the designer's attention more on fostering productive social interaction. The five design principles introduced in this paper address these tensions by focusing *primarily* on social learning via interactive participation, and only *secondarily* on individual learning outcomes. Put differently, this means that designing and refining features should focus on helping players and teachers informally assess engaged participation in interactive discourse concerning the to-be-learned knowledge. This is theoretically consistent with Greeno's (1998) notion of *engaged par-*

ticipation and practically consistent with Engle and Conant's (2002) notion of *productive disciplinary engagement.*

The Five Design Principles of Participatory Assessment

Participatory Assessment is rooted in prior multi-year design studies of interactive multimedia for genetics (Hickey & Zuiker, 2013) and space science (Hickey, Taasobshirazi, & Cross, 2013). Insights from those studies were subsequently refined in several parallel strands of design research. This included five annual cycles of design research in *Taiga*, the first of many "worlds" that now make up *Quest Atlantis*. Taiga is a 15-20 hour game involving ecological science and socio-scientific inquiry for grades 4-6, in which students investigate the reasons for declining fish populations in a river. The game is organized around five *Quests* where players draft and submit *quests* (essentially field reports) for Ranger Bartle. The teacher then "plays" the role of Ranger Bartle in reviewing and accepting the reports. Practically speaking, this means Taiga has the potential to support a great deal of student writing, which distinguishes it from many educational games.

The studies were carried out with two elementary school teachers over five years. One teacher taught a single class of academically talented fourth graders from 2005-2007. The other teacher taught four classes of sixth graders from 2006-2010. The specific game design principles and specific features in Taiga will be described below in the context of five game design principles that emerged in this research.

Principle 1: *Let Contexts Give Meaning to Knowledge Tools*

The first step in Participatory Assessment is reframing targeted knowledge as *tools.* This reframed learning as practicing using tools appropriately in particular contexts. In Taiga, this meant first defining a compelling narrative game that required using knowledge of ecology and socio-scientific inquiry to play. This then meant fine-tuning that narrative to require the student to use more of that knowledge to succeed.

The initial design of Taiga transformed the concepts of elementary ecological science into knowledge tools that could be used to solve important *socio-scientific* problems. Such problems evade simplistic explanations and require balancing a host of issues in advancing plausible hypotheses and solutions. In Taiga, players serve as apprentices to Ranger Bartle. In this way, Taiga (and most subsequent QA worlds) incorporated the foundational characterization of situative instruction as "cognitive apprenticeship" (Collins, Brown, & Newman, 1989; Lave, 1977). As elaborated in Barab, Sadler, et al., 2007, p. 61-62), the initial effort to "narratize" ecological science in Taiga involved creating a narrative that was compelling to students and whose solution required using scientific inquiry to use scientific resources in the service of identifying underlying cause(s) of the core problem introduced by the narrative.

The initial version of Taiga was implemented in 2005 by the fourth grade teacher across fifteen periods. An open-ended essay on socio-scientific inquiry was used in 2005. The students in 2005 made tremendous gains in their socio-scientific essays. This made sense because the students really had no experience with these ideas or this kind of scientific inquiry before Taiga. However, the scores on the achievement test only went up slightly and the gain was not statistically significant (Figure 1). More importantly, interpretive analyses of the quest submissions showed that many students had failed to even mention the targeted scientific practice or resources in their reports (Barab, Sadler, et al., 2007).

As elaborated in Barab, Zuiker et al., (2007) the design team then set out to "scientize the narrative." They framed increasingly formal relationships between the targeted scientific formalisms (i.e., tools) and their context-of-use in Taiga. Their continued refinement of the narrative and the assessments distinguished between formalisms that are *embodied* by, *embedded* in, or *abstracted* from the social and material context of the game. The revised Taiga was implemented in 2006 by the same fourth grade teacher with a new class. The curriculum-oriented assessment was revised to include some knowledge that students might have previously encountered, and the achievement test was recreated to include more items for just four of the most relevant state science standards. The revisions were effective in that many more of the students enlisted many more of the domain formalisms in their quest submissions, and did so more meaningfully. The gains in understanding of the new curriculum-oriented assessment were smaller but were still statistically significant; the gain in achievement on the standards-oriented test doubled from the previous year and was statistically significant (Figure 1). Later in 2006, a sixth-grade teacher implemented Taiga for the first time in two of his four sixth grade science classes. As shown in Figure 2, the gains in understanding and achievement were statistically significant for both pairs of classes, but both gains were larger in the Taiga classes (Hickey, Ingram-Goble, & Jameson, 2009). Additional analysis showed many other very positive outcomes in the QA group and showed that the knowledge the students did gain lasted much longer (Barab, Gresalfi, & Ingram-Goble, 2010).

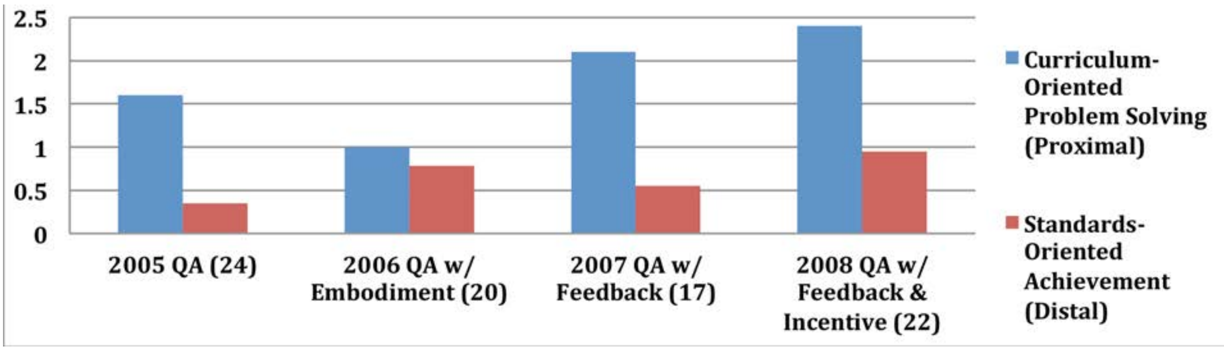

Figure 1: Learning gains in fourth grade classe across years (in SDs with number of students)

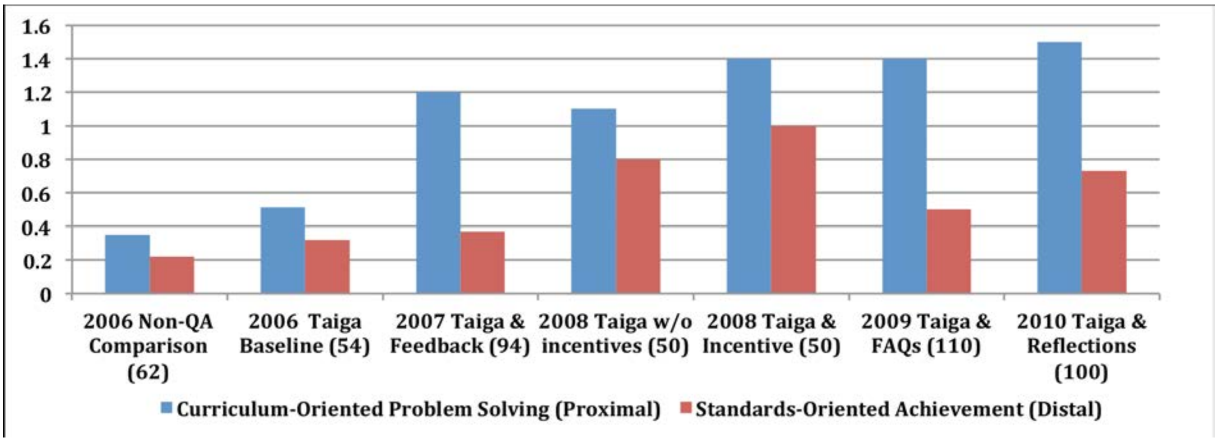

Figure 2. Learning Gains in sixth-grade classes across years (in SDs, with numbers of students)

Principle 2: *Recognize and Foster Productive Disciplinary Engagement*

This second design principle emerged from a more focused series of refinements around the process of drafting, submitting, and revising the five written quests that organized much of the gameplay. Analysis of the quests submitted in the sixth grade classrooms in 2006 confirmed that the quality of the submissions was modest, the feedback provided was hasty, and the revised submissions did not improve. An ecology graduate student was invited to join the team in 2007 and improve our performance assessment, quests, and activities leading up to the quests. She created the *Lee River* performance assessment described below and helped create two new information resources to help foster more productive disciplinary engagement around the questing process. The first new resource was a detailed scoring rubric for the crucial second quest that required the most synthesis of knowledge. The rubric provided carefully worded examples and feedback that aimed to make this structured discourse more productive and more disciplinary. Examples and descriptions of *incomplete, partial, nearly complete,* and *complete* submissions were included, along with feedback text that could be cut and pasted into the feedback window and then customized as desired for each student. The second new resource consisted of screens of information that were embedded for players to use when revising their reports.

In 2007, both teachers implemented this revision of Taiga. The submitted quests showed that these refinements led students to use many more of the domain tools *and* use them more appropriately, with the resubmitted reports containing evidence of this much more than the initial reports that students were asked to revise. As reported in Hickey, Ingram-Goble, & Jameson (2009) and shown in Figures 1 and 2, we also observed dramatically larger gains in understanding and larger gains in achievement compared to 2006. However, uneven and generally low use of feedback made us wonder about motivation to use feedback. While incentives are popular in commercial video games, they remain controversial in educational video games. In 2008, we removed the incentives in Taiga from two of the sixth grade classes and emphasized intrinsic reasons for succeeding (such as helping the park and helping Ranger Bartle do his job). In the other classes, we made the incentives more salient and added some additional ones. In addition to the backpacks and hats, accepted quests also resulted in a badge that students could place on their avatar, which corresponded to the quality of the submission as judged by the teacher/ranger (*knowledgeable, expert,* or *wise*). We also placed a physical "leader board" on the wall in those two classrooms.

That the incentives led players to enlist formalisms more appropriately suggested that they were *not* taking short-cuts in their submissions to get the incentives. While we were unable to systematically compare feedback use in the two groups, the students in the incentive classes made significantly larger gains in understanding and some-what larger gains in achievement (see Figure 2). Additionally, they reported slightly higher levels of motivation while completing their reports and slightly larger gains in interest in solving these kinds of problems. Thus, we found no negative consequences of incentives and some positive consequences.

In 2009, we also revised the embedded feedback to make it easier to use. The previous feedback screens were slightly hard to navigate, and players had to commit to a whole series of them. We changed it so that when students went to the technician for help, he presented them with a list of about 20 questions. We also further grounded this feedback into the narrative problem context. While this certainly made the feedback more accessible, gains in understanding for the sixth graders were unchanged.

Principle 3: *Assess Reflections Rather Than Artifacts*

One of the distinguishing feature of QA and what arguably makes it so educationally useful is that players generate "artifacts" that are personally meaningful and that feature directly in the game narrative. Artifacts are things that have been made meaningful (Lave & Wenger, 1991). The artifacts that students create in project-based learning are more meaningful than worksheets because the personalization possible in a project means that the artifact takes on additional meaning. In some games, these artifacts are virtual items that players have collected or won. In Quest Atlantis, these artifacts include written communications such as commentaries. Because of their role in rewarding, acknowledging, and supporting learning, the design and function of artifacts is an important consideration and a potential source of tension in designing educational games.

In 2009, we began experimenting with reflection questions that built upon the sub-narrative that Ranger Bartle was a busy mentor. The reflections were framed as requests from Bartle to help him determine whether each report showed evidence that they were fulfilling their responsibility as an apprentice. The reflection questions for Quest Two were as follows: *Remember, you are here as an apprentice. Help me make sure you are becoming a skilled ranger. Explain what it is about your quest that shows you understand the following things about hypotheses:*

1. *The things that a hypothesis must include to be scientific;*
2. *That a testable hypothesis must have enough detail for someone else to test it if they want;*
3. *That experts always look for and include other alternative explanations for their hypothesis;*
4. *That experts always consider what they might have overlooked.*

We asked the teacher to review the reflections primarily and were pleased with the way doing so seemed to streamline the reviewing process. Sometimes, when students went to draft the reflection, they would realize that there were things missing from the submission, which they would then go back and complete. We realized that completing the reflections for one quest submission could shape the way that students approached the next submission. The next time, it was expected that students would *start* their submission by considering the reflection while drafting and revising the report; this, in turn, had the potential to shape engagement in the activities leading up to each report. Reviewing the Quest Two submissions in 2009 showed that most (but not all) students took the reflections seriously, and we concluded that reflections were a promising strategy for increasing disciplinary engagement while streamlining the review process. These ideas did not fully come together until the final 2010 study, and several factors precluded systematic study of the reflections. While gains in understanding and achievement were about the same, we ended up with a more sustainable teacher workload. Compared to 2008, the number of resubmissions declined (from an average of 3.1 to 1.9 per student).

Principles 4: *Assess Individual Understanding Prudently*

The last two principles in the model respond to one of the central tensions facing educational game designers. In our view, all learning involves assessment, which means that the clear distinction between "instruction" and "assessment" disappears. This view also does away with the sharp distinction between formative and summative assessments. Rather, particular assessment practices are understood in terms of their potential formative and summative functions, along a continuum ranging from informal to formal. Of course, assessment and testing raise complex issues about the *validity* of the inferences that can be drawn from scores. A situative perspective on assessment argues that one must specify a theory of knowing *and* a theory of learning when discussing validity.

Achievement tests can provide valid evidence of how much individuals know about broad domains of knowledge that accrues over very long time scales; this means that achievement tests are hard-pressed to provide valid evidence of how much individuals learn from specific learning activities. A situative perspective on assessment raises complex theoretical issues that are beyond the scope of this paper and are elaborated elsewhere (Hickey & Anderson, 2007; Hickey & Zuiker, 2012). The most important point for this chapter is that situative perspectives suggest careful *alignment* of less formal assessments with more formal assessments. Doing so allows the summative function of the more formal assessment to "protect" the formative function of the less formal assessment.

Administering a curriculum-oriented assessment before and after Taiga showed how much particular students were learning about the scientific concepts in Taiga and how much students overall were learning about particular concepts. It also showed that some students understood some of the concepts *before* playing. These insights were used to refine the Taiga activities and quests. The increasingly larger gains in understanding showed that these efforts were successful. However, we did not have the teacher use the Lee River assessment to provide feedback directly to learners. While doing so might have supported more *student* learning, it would have undermined *project* learning about the effectiveness of the curriculum. This is because providing individual feedback would focus the teacher's attention too directly on the abstracted formalisms in the assessment items and would likely prepare students too directly for the post-test throughout the activity.

Principle 5: *Measure Aggregated Achievement Discreetly*

Even with our efforts to preserve the validity of the curriculum-oriented performance assessment, the iterative alignment of Taiga to the assessment still introduced an unknown (and practically unknowable) degree of "construct-irrelevant easiness" (Messick, 1994). This points to a core tension in game-based assessment. These refinements meant that some part of the improvement from one cycle to the next was the result of Taiga better familiarizing players with the problems that would appear on the Lee River. This meant that the Lee River could not yield valid evidence in comparisons with other curriculum or predict the impact on external achievement tests. An additional instrument was needed.

A "standards-oriented" achievement test was created by randomly sampling items from pools of items that were aligned to targeted standards, independent of Taiga. Because such items can be answered quickly, it was possible to include a large amount of items. As long as an individual has not been directly exposed to the specific associations on the test items, it is possible to efficiently and reliably compare how much individuals know about a domain of knowledge. Such tests should not be used to directly shape the way a curriculum is designed or enacted. As argued above, the human mind is remarkably efficient at learning information well enough to use it to recognize specific associations. It is all too easy when designing and/or teaching a curriculum to reference the specific associations that are needed for specific test items.

Putting it All Together in Iterative Refinements

What makes Participatory Assessment work is the way that the activities at one "level" are motivated and evaluated by the outcomes at the next. In Taiga, this meant focusing directly on participation in the game, less directly on understanding, and very indirectly on achievement. In educational game design, this means fostering participation before assessing understanding, and fostering understanding before measuring achievement. Learning across levels is increasingly formal and encompasses increasingly broad knowledge. It is also decreasingly contextualized and occurs over longer and longer timescales (Lemke, 2000). Rather than presenting different or more difficult problems across levels, students interact with increasingly formal representations of the same domain of knowledge across the levels. The ultimate power of this alignment comes from its potential for coordinating the activities of all of the participants. This includes the students (because activity at one level can be motivated by the desire to succeed at the next level), the designers (by providing a target for activities at each level), the teachers (by providing a goal to shape the enactment of each level), and the researchers (by providing project goals and summative evidence of success). Because the knowledge is transformed from one assessment level to the next, evidence of the transfer is obtained. By doing so over three or more levels and extending out to the level of the distal achievement test, valid evidence of achievement impact is obtained. However, this evidence is obtained without resorting to directly exposing students to specific associations that might appear on the targeted test.

The continued improvement to engagement, understanding, and achievement over implementation years suggests that this model helps deliver the diverse sorts of learning outcomes and evidence of those outcomes that have long eluded educational innovators. Additional support for the value of this model comes from similarly increased outcomes in the other programs of research in which these same design principles were refined. These studies have included high school language arts (e.g., Hickey, McWilliams, & Honeyford, 2011), online graduate education courses (Hickey & Rehak, 2013), and hybrid undergraduate lecture courses in telecommunications

(Walsh & Hickey, 2011)

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A Quasi-Experimental Study of Badges, Incentives, & Recognition on Engagement, Understanding, & Achievement in *Quest Atlantis*

Daniel T, Hickey, Indiana University, dthickey@indiana.edu
Michael J, Filsecker, University of Duisberg-Essen, michael.filsecker@uni-due.de

Abstract: This study in the Quest Atlantis multi-user virtual learning environment explored whether design-based methods and participatory models of assessment and engagement could advance the nagging debate over the consequences of educational incentives. Four classes of sixth-grade students completed a 15-hour ecological sciences curriculum that was rich with feedback and opportunities to improve. Students in two of the matched classes were able to publicly display their success, via a physical leader board and virtual badges that they could place on their in-game avatar. These students showed more sophisticated engagement (enlisting more scientific formalisms and doing so more appropriately), significantly larger gains in understanding (on a challenging performance assessment), and larger gains in achievement (on a test of randomly sampled items aligned to targeted content standards); their intrinsic motivation during the game was slightly higher, and motivation for the domain increased slightly more.

The ubiquity of youth video gaming and the appeal of the newest generation of immersive virtual gaming environments have utterly transformed youth recreation. Recognition of the tremendous level of (non-academic) learning occurring in commercial video games has moved the design of *educational* video games from a research niche to a national and international priority. One of the central challenges in designing educational video games concerns the use of *incentives.* While most commercial video games offer players some form of *incentives* (such as points or "levels") to motivate their progress, incentives remain controversial in education. Cognitive theorists assume that incentives undermine intrinsic motivation and subsequent engagement via the *overjustificatio*n effect (Deci, Ryan, & Koestner, 2001, Lepper, Greene, & Nisbett, 1973). This occurs when an extrinsic incentive is introduced for activity which was previously intrinsically interesting. After the introduction of the incentive (e.g., a prize or a certificate) the individual subsequently attributes the basis for the activity to the extrinsic reward. Hundreds of studies have shown that "extrinsic" incentives direct attention away from intrinsically motivated learning, leading to diminished engagement once incentives are no longer offered (Tang & Hall, 1995). Reflecting the antithetical relationship between cognitive and behavioral theories of motivation, analyses of the same body of studies by behaviorally-oriented theorists support the conclusion that the negative consequences of incentives are limited to specific easily-avoided situations (Cameron & Pierce, 1994). This paper describes a quasi- experimental study that examined whether newer sociocultural perspectives on assessment and motivation might shed new light on this enduring debate.

Sociocultural Perspectives on Incentives

Newer sociocultural theories of knowing and learning offer a different way of thinking about incentives and motivation that might move this debate forward. In their groundbreaking paper on *cognitive apprenticeship,* Collins, Brown and Newman (1989) suggested that the corrosive educational effects of competition (which is typically fostered by incentives) may be more the results of impoverished learning environments that lacked opportunities to improve and the formative feedback needed to do so. Most of the prior studies of incentives were conducted in highly structured laboratory settings or very traditional classrooms. This suggests that the newest generation of educational video game incentives might have positive consequences that outweigh or even eliminate any negative consequences. Furthermore, the rich interactive narratives in the latest generation of immersive video games and the participatory culture of many networked learning environments might reverse the overjustification effect via what Gresalfi, et al. (2009) called *consequential engagement*.

The meaning of educational engagement is bound to views of learning. Prior scholars have advanced notions such as *mindfulness* (Salomon & Globerson, 1987), *intentional learning* (Bereiter & Scardamalia, 1989) and *committed learning* (diSessa, 2000). As Dewey put it a century ago "…the educational significance of effort, its value for an educative growth, resides in its connection with a stimulation of greater *thoughtfulness,* not in the greater strain it imposes" (Dewey, 1913, p. 58). Sociocultural approaches highlight Dewey's thoughtfulness as the process by which students engage in an activity, interact with each other and use resources and tools purposefully. Engel and Conant's (2002) notion of *productive disciplinary engagement* highlights (a) the number of students making substantive disciplinary contributions, (b) the number of disciplinary contributions made in coordination with each other, (c) students attending to each other and making emotional displays, and (d) students spontaneously reengaging. In this characterization, the role of discourse is key to supporting any claim concerning engagement.

Multi-Level Assessment Model

This study extended a "multi-level" model of assessment to the study of student engagement. Doing so promised valid inferences of the translation of the intense engagement with video games to academic subject matter (Roschelle, Kaput, & Stroup, 2000). The difficulty of such translations lies, in part, in the unique affordances of educational games (i.e., formative feedback and numerous low-stakes opportunities to improve). While the formative functions of these features enhance learning, they can compromise evidential validity of assessments used to examine engagement and learning in video games. This study assumes that doing so calls for assessments along different "levels" of learning outcomes (Ruiz-Primo, Shavelson, Hamilton, & Klein, 2002). The current study assumes that using different learning outcomes across levels means that formative feedback at one level does not directly coach or prepare students for the outcomes at the next level. This provides a tractable way of controlling for the construct-irrelevant variance (Messick, 1994) that occurs when students are given feedback for solving problems that are similar to the problems that appear on an assessment (Hickey, Zuiker, et al., 2006, Hickey & Anderson, 2007). In this way, the alignment of learning across multiple levels maximizes consequential validity (i.e., the formative function of assessment) at one level while preserving evidential validity at the next level (the summative function). Doing so across three or more levels promises to overcome the complexities of assessing learning outcomes from educational games (as described by Annetta, Minogue, Holmes, & Cheng, 2009, p. 79).

This study extended the multi-level assessment model as it had emerged in design studies of Quest Atlantis's *Taiga* ecology game (Barab, et al., 2011) to the study of incentives and their impact on engagement. Learning was conceptualized in terms of four different levels of learning outcomes that were pragmatically informed by the three "grand theories" of learning outlined in Greeno, Collins, & Resnick (1996). First, a situative/sociocultural perspective was used to conceptualize (1) the immediate-level enactment of sequences of inquiry-oriented game activities and (2) close-level participation among the player, teacher, and non-player characters in writing and revising written "quests" after those activities. The model then uses a cognitive/rationalist perspective to frame learning in terms of (3) proximal-level conceptual understanding assessed with a curriculum-oriented performance assessment. Finally, the model uses a more behavioral/associationist perspective to frame learning in terms of (4) distal-level achievement measured with a multiple-choice test. This means that the collected evidence of close, proximal, and distal learning (a) were increasingly removed from the enactment of the Taiga inquiry activities, (b) were increasingly oriented towards a broader curricular scope, and (c) used increasingly abstract representations of knowledge.

This study attempted to extend the multi-level assessment design model to the issue of incentives by building on emerging situative/participatory approaches to motivation (Greeno et al., 1998; Hickey, 2003). At the close level, we examined students' written quests as evidence of their success while participating in the interactive practice of drafting a quest. At the proximal level, we examined individual players' self-reported motivational states during that same quest. At the distal level, we examined players' more enduring self-reported personal interest towards the kinds of problems they were solving in the game. This logic and the relationship between the levels of assessment and the levels of engagement are explored in more detail in Hickey & Schaffer, 2006.

Methods

This study was the third in a series of annual design studies of the 15-hour Taiga curriculum with the same teacher and population of students. In the previous year, new formative feedback resources had been introduced into the game, including sophisticated rubrics to help teachers review the quests and provide feedback, and a series of help screens offered by a non-player character that students could reference when completing the crucial second quest. These new resources led to substantially larger gains in understanding and achievement. However, the larger gains were associated with the students who elected to use them. Only twenty percent of the students viewed all of the feedback screens, while another twenty percent did not view them at all (Hickey, Ingram-Goble, & Jameson, 2009). This suggested that somehow motivating more students to access more of the resources and do so more meaningfully should further enhance learning outcomes.

Incentives like those that are so effective in commercial video games were an obvious strategy for attempting to motivate this engagement. However, as hinted above, there are lingering concerns about the negative consequences of incentives among cognitive/rationalist motivation theorists, and an enduring debate with behavioral theorists who argue that the negative consequences are limited and easily avoided. In order to explore this issue from a new perspective, a quasi-experimental study was conducted. For two of the classrooms in this study, the teacher's acceptance of a written quest at one of three increasingly accomplished levels (proficient, expert, or wise) was rewarded with a corresponding badge that players could affix to their in-game virtual avatar. Additionally, students in this Public Recognition (PR) condition were invited to move a paper version of their avatar up and across a physical "leader board" that was prominently placed in the room. In two other classrooms taught by the same teacher in the same semester, students in the Non Public Recognition (NPR) condition were not offered badges or a ready means to communicate their level or progress to the other students. Consistent with Lepper & Malone (1987), the incentives and all of the information in the game about them was replaced with text encouraging players to work hard to save the park and become more capable apprentices.

To explore these issues, the study was designed to test the following hypotheses: *Hypothesis 1:* Students in the PR condition will engage more deeply in the process of drafting and revising their quests, use more relevant scientific formalisms, and use those formalisms more correctly than students in the NPR condition; *Hypothesis 2:* Students in the PR condition will exhibit significantly larger gains in conceptual understanding of the targeted science concepts and achievement of the targeted science standards than students in the NPR condition;
Hypothesis 3: There will be no difference between the PR and NPR conditions in self-reported intrinsic motivation during the second quest, and no differences in impact of the game on personal interest in learning to solve these types of scientific problems.

This research was conducted at a public elementary school in a medium-sized university town in the Midwestern US. The students were predominantly Euro American and most came from well-educated professional families. In this study, average grades from prior work were used to identify pairs of similar achieving classes, and one class in each pair was assigned to the Public Recognition (PR) and the Non Public Recognition (NPR) condition. Consent to participate in the study was obtained from almost every student, resulting in 106 participants (56 females and 60 males).

Engagement and learning were assessed at the *immediate, close, proximal* and *distal* levels. To assess engagement and learning at the immediate level we analyzed the number of screens of formative feedback students accessed using log files. This reflected our tentative assumption that choosing more pages represented more intentional engagement in the structured discourse of the revision process. To assess learning and engagement at the close level, we analyzed the quality of the submissions of crucial Quest 2 (scored by researchers) and assessed the improvement from initial to final submission, given feedback from the teacher (via the park ranger character). We used a conventional rubric to assign points according to students' right/wrong answers to questions in Quest 2. Specifically, a 14-point scale rubric assigned six points for summarizing the various water quality indicators at three sites of Taiga, four points for explaining what the processes were (i.e., erosion and eutrophication), and four points for describing the dynamic relationship between indicators and processes. While this captured student accuracy, it did not capture the meaningful appropriation of concepts in the domain discourse. For example, one student could say *dirt from Site B got into the river*, while another one could say *the sediment from Site B is eroded into the river*. By using the 14-points rubric, both students would have earned one point, without distinguishing the nuances such as the difference between *dirt* and *sediment* and between *got into* and *eroded*. In a sense, we were aiming at the *disciplinary* engagement pointed out by Engle and Conant (2002). Therefore, we quantified the verbal data (Chi, 1997) to capture this domain-specific or *disciplinary* discourse around students' Quest 2 submissions (n=106). Initial and final submissions in Quest 2 were coded in terms of the meaningful appropriation of nine relevant scientific concepts. The text of the submissions of all students (n=106) was coded using the NVivo qualitative analysis software program. According to Chi (1997) one of the critical steps in analyzing verbal data is the issue of segmentation or grain size. In any case, the grain size selected needs to correspond to the research questions asked. We used small propositions that contained the targeted scientific concept, under the hypothesis that the incentives would prompt the students to use the academic content embedded throughout the game in a *mindful* way. This contrasts with the hypothesis that follows in cognitive/rationalist views of incentives that would lead to more surface-level extrinsically motivated engagement. We were interested in capturing students' engagement with the content in a progressive, knowledgeable way as a result of the incentive manipulation, instead of students' actual representation of knowledge (Chi, 1997) or scientific argumentation (e.g., Kelly, Drucker & Chen, 1998).

To examine engagement at the proximal level, we developed a scale to assess players' situated motivation regarding the Quest 2 activity. The scale consisted of 4 or 5 Likert-type items (strongly disagree, disagree, neutral, agree, or strongly agree) for each of the following subscales of the motivational states that prior research has shown to be diminished by incentives: *interest* in the activity, *value* for completing the activity, *perceived competence* during the activity, and *effort* completing the activity. So long as the individual scores for each set of items are internally reliable, scores on each scale are presumed to be indicative of various aspects of students' cognitive engagement during the tasks (see Fredricks, Blumenfeld, & Paris, 2004). Once their Quest 2 submission was accepted, students completed the brief survey. The survey asked students, "How did you feel while completing Quest 2?" The survey also encouraged students to respond honestly and assured students that their responses were confidential.

To examine engagement at the distal level, we measured changes in personal interest in solving the types of problems students were learning to solve in Taiga. One of the main concerns with incentives is that they supplant existing intrinsic motivation towards activities with the extrinsic motivation offered by the incentive (the "overjustification"). Hundreds of prior studies in laboratories or traditional classrooms have showed that extrinsic incentives lead to decreased free choice engagement in the incentivized activity. Many of those studies also examined self-reported interest in the activities (and sometimes instead of) free choice engagement. To this end, we measured students' self-reported personal interest in the three types of problems that they were learning to solve in Taiga: water ecology problems, complex scientific problems, and controversial socio-scientific problems. An 18-item survey was created consisting of six Likert-scale items for each type of problem and was administered before and after students played the game.

To examine learning gains at the proximal level, we used the *Lee River* performance assessment developed in the prior design cycles. The assessment was "curriculum-oriented" in that it asked students to solve similar problems as in Taiga but in a somewhat different context. The assessment had been created alongside extensive refinements to Taiga the previous year and was designed to be highly sensitive to different enactments of the curriculum. It involved another fictional watershed and a range of stakeholders who had similar (but not identical) effects on the ecosystem. For example, both Taiga and Lee River involve stakeholders with different land use practices who are arranged along a river. The stakeholders from both scenarios impact their ecosystems by doing things that cause erosion and eutrophication; however, erosion is caused by loggers in Taiga and by construction in the Lee River. To capture a range of understanding at the pretest and the posttest, the items covered included a broad range of difficulty. It included several multi-part items that started out with simple tasks that most students would be able to answer without instruction, and proceeded to a few complex items that focused on the nuances of scientific hypotheses, the relationship between social issues and scientific inquiry, and the relationship between water quality indicators such as dissolved oxygen and processes like eutrophication. A 21-point scoring rubric was used to score completed assessments, with a subset of assessments scored by two researchers to establish reliability.

To examine learning gains at the distal level we used the same 20-item test that had been created the previous year by random sampling from pools of items aligned to the four targeted content standards, but independent of the Taiga curriculum. Such standards-oriented tests are necessary to support claims of impact on externally-developed achievement measures and to compare the impact of different curricula that target those standards. Such tests are not particularly sensitive to specific interventions and represent a relatively ambitious target for innovative curricula like Taiga.

Results and Conclusions

For engagement and learning at the immediate level, analysis of the log files found no significant difference in the number of feedback pages accessed for the PR (M=8.69, SD=6.91) and the NPR (M=9.24, SD=5.98) conditions (Mann–Whitney U =1285, n_1=51, n_2=55, p=.452). At the close level, improvement scores for the initial and final Quest 2 submissions (using a 14-point scale; inter-rater reliability = .85) did not reach statistical significance between conditions (Mann–Whitney U =1099, n_1=47, n_2=51, p=.475). In addition, a one-way MANOVA was conducted to compare the effects between conditions on the meaningful appropriation of the scientific concepts as enlisted during the drafting of Quest 2. The analysis of the coded initial and final submissions revealed higher levels in the PR condition, but the difference did not reach statistical significance [Wilks' Lambda =.973, F(1,102)=2.797, p=.097] Therefore, strictly speaking, we found no evidence of negative consequences of incentives engagement in the written discourse around Quest 2.

Concerning proximal engagement, all four self-reported assessments of motivational orientation during Quest 2 revealed high internal reliability (all alphas over .85). This was crucial, since unreliable measures could have masked consequences of incentives in random variance. A one-way between subjects ANOVA was conducted to compare the effects of the incentive and non-incentive conditions on perceived interest, value, competence, and effort. There was no significant effect on any of the variables [F(1,106)=.826, p= .366; F(1,106)=.051, p =.821; F(1,106)=.467, p=.496; F(1,106)=.321, p=.575, respectively]. While none of the four differences reached statistical significance, the fact that slightly higher scores were observed for all four of the aspects in the PR condition argues strongly against the predicted negative consequences from the incentives.

For distal engagement the scales of interest in solving the three different types of problems showed acceptable levels of reliability (alphas over .80) at both administrations. A one-way repeated measures ANOVA was conducted to compare the effects of incentives on three indices of interest. None of the tests yielded significant difference between conditions [Wilks' Lambda =.99, F(1,102)=.442, p=.508;Wilks' Lambda =.99, F(1,101)=.703, p=.404;Wilks' Lambda =.99, F(1,101)=1,026, p=.314], supporting our initial hypothesis that the "overjustification" is unlikely to occur in contexts such as QA. These results suggest that the introduction of incentives in this environment did not undermine personal interest (or presumably subsequent free-choice engagement) in these times of scientific investigations.

For proximal learning, a one-way repeated measures ANOVA tested the effects of incentives on students' gains in conceptual understanding. Students in the PR condition gained significantly higher levels of understanding than students in the NPR condition [Wilks' Lambda =.946, $F(1,99)=5.6$ $p=.02$]. This represented the difference between 1.4 and 1.1 SD gain, given the pooled standard deviations across the score points. Importantly, the differences in gains between the two classes in each condition were not statistically significant ($F < 1$). Thus, the students in the incentive condition developed significantly greater understandings of the concepts, topics and processes associated with solving scientific and socio-scientific problems involving water quality.

For distal learning, the achievement tests revealed strong internal consistency, and showed that students in the PR condition gained 5.44 points compared to 4.02 points for the other students. Given the variance within the scores, this was a difference between gains of 1.1 and 0.8 SD. A one-way repeated measures ANOVA revealed that this difference in gains did not reach conventional criteria for statistical significance [Wilks' Lambda =.972, $F(1,114)=3.234$, $p=.075$, gains between classes within groups was again $F < 1$]. However, such a gain seems highly unlikely to have occurred by chance given the corresponding significant difference in gains in proximal understanding. This is an example of the aforementioned "echo" and an illustration of the advantage of assessing learning outcomes across multiple increasingly formal levels.

In summary, the incentives as enacted in this study were not shown to motivate students' engagement with the learning activities such as drafting and revising Quest 2 and using the resources embedded in the game. Therefore, Hypothesis 1 was not supported. However, results showed a significant larger gain in the understanding of ecological processes (proximal), and a non-significant differential gain in achievement (distal), both in favor of the PR group. Therefore, Hypothesis 2 was partially supported. Finally, examination of engagement at the three levels failed to uncover any of the potential negative consequences of the incentives, supporting our third hypothesis.

Implications and Significance

These findings lend initial support to the argument advanced by Collins, Brown, and Newman (1989) that the negative consequences of competition may be more indicative of impoverished learning environments and the lack of feedback and opportunity to improve, than of a fundamental consequence of competition. Relative to the conventional learning environments in which incentives have generally been studied, educational games are interesting and engaging contexts that offer extensive feedback, which can have a positive impact on students' task involvement. Additionally, it seems possible that other game features such as fantasy, rules and challenges may further insulate students from the sorts of negative consequences that have been associated with incentives in other studies.

This study provides some initial empirical support for the speculations about sociocultural theories of engagement in Author (2003 & 2006). Rather than (a) using incentives haphazardly or (b) attempting to prove their fundamental impact, we believe that designers should ask about the motivational design features concerning their impact on immediate-level and close-level engagement in learning. While there are likely many ways of doing so, we believe that this more process-oriented and contextual analysis offers a helpful starting point. We also believe that this study shows some initial value in extending the multi-level model of assessment used in past studies to consider engagement and motivation as well.

Arguably, the multilevel assessment model applied in this study begins to address a core validity issue that has long plagued the assessment of individually-oriented motivational interventions (see Adelman & Taylor, 1994). Just as with our learning outcomes, our formative efforts to refine engagement at one level do not undermine the evidential validity of the engagement outcomes at the next level. In other words, there was nothing about close-level motivational intervention (i.e., incentives and competition) that might have directly encouraged students to characterize that activity as more interesting or engaging on the proximal-level survey items. In this way, we examined the more direct consequences of incentives and competition on the students' engagement in the questing activity. At the same time, we indirectly examined the consequences of incentives and completion on student's self-reported cognition during those activities and of changes in self-reported interest towards those activities. This seems like a promising way around the obvious dilemma facing many motivational interventions: programs that focus directly on changing behavior may deliver behavioral change, but fail to impact cognition, while programs that focus directly on cognition may indeed impact cognition but fail to deliver enduring changes in behavior. Likewise, the model represents an extension and may well complement current analytical strategies based on discourse and video analysis (e.g., Azevedo, 2006; Engel & Conant, 2002) by introducing performance and achievement levels together with self-reported motivational states. In summary, while protecting the validity of outcome claims, the model also emphasizes the assessment of the process of engagement and learning encompassing the “hybrid research methodologies” characteristic of multidisciplinary fields such as CSCL (Stahl, Koschmann, & Suthers, 2006). Thus, the model provides a promising solution to the assessment of learning beyond sociocultural perspectives on teaching and learning.

Finally, the increased learning outcomes across the three design cycles demonstrates the broader value of this assessment-driven multi-level model of assessment. While the present study focused on the impact of incentives, numerous other refinements had been made to the Taiga curriculum that were informed by evidence obtained at the various levels. Of course, some (but certainly not all) of the increased gains were due to teachers learning. Most innovators who have attempted to impact valid measures of external achievement know how difficult it is to obtain gains of this magnitude without resorting to expository direct instruction. In addition to offering a way forward on enduring design controversies like incentives, the multi-level model appears to be a promising way to deliver the evidence of achievement impact that is demanded by many educational stakeholders without compromising the more authentic learning supported by innovations like Quest Atlantis.

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Designing a Game-Inspired Learning Management System

Caitlin Holman, Stephen Aguilar, Barry Fishman, University of Michigan
cholma@umich.edu, aguilars@umich.edu, fishman@umich.edu

Abstract: Through the experience of implementing game-inspired grading systems in undergraduate courses at a large university, we found ourselves pushing the boundaries of what was functionally possible in current Learning Management Systems. Simultaneously, students reported difficulty understanding the core requirements of the course 'game', recognizing the various pathways available for them to succeed, and assessing their course performance. In response to these articulated needs (and using the classic videogame user dashboard as inspiration) we developed a custom learning management system to better support game-inspired courses and foreground the affordances of gameful course design.

Supporting Gameful Grading Systems

Numerous educators are experimenting with implementing game-inspired course designs in traditional education settings (Sheldon, 2012; Fishman & Aguilar, 2012). These courses often feature curriculum and assessment designs that are difficult to support in the standard Learning Management System (LMS). The administrative tasks involved in managing this style of course—particularly the various types of material submitted on irregular schedules and the importance of swift response to student action—also differ significantly from those of traditional courses, and thus present a technical challenge to instructors using non-optimized software. In our case, the design of GradeCraft was in part a response to complaints from students who were unsure of their progress in the course, and who struggled to decide what they should work on to achieve their desired outcome/grade. Over the process of deploying this system, and at the request of teachers using the software, we have increasingly built features designed specifically to support the instructional challenge of providing rapid feedback for students in a variety of forms (text, badges, learning objectives progress, etc.). Our system is a platform for experimenting and optimizing our course designs.

Our Design Process

We began the design process by taking an inventory of techniques currently used in gameful courses. This produced a list that included such techniques as: using points and incremental levels instead of grades; awarding badges to recognize achievements and skill-acquisition; allowing students to redo assignments as many times as necessary to succeed; giving students the ability to decide the types of assignments they would attempt; allowing students to determine how much assignments would count towards their final grade; having students work together in both self-selected and pre-arranged groups on larger, sometimes competitive, challenges; sharing earned skills amongst students; requiring the completion of specific assignments and tasks in order to 'unlock' other challenges; and displaying generalized information regarding classmates' performance.

While these represent relatively simple game mechanics (and each is being actively researched as to its specific pedagogical value and motivational impact in the classroom), we hoped building an interface that included these tools would solve the initial comprehension and logistical issues students were experiencing, and would establish a solid foundation from which to build more nuanced gameful functionality in the future. We have deployed the interface in four classes so far, making iterative changes after each round in response to user testing, student survey feedback, and instructor requests. We are also employing a design-based research approach, with the intention of producing a usable tool that is rooted in theory (Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003).

The Student Dashboard

From the student perspective, our system functions as a single-page dashboard displaying their comprehensive course progress. The top portion of the display includes a visual chart of the points they have earned (broken down by color to reflect the type of assignment), a list of the badges they have earned paired with the badges still available to work on, and a graph of their progress towards achieving the course learning objectives. It also displays a To Do list that highlights upcoming assignments, assignments that could be redone to show improved content or skill mastery, and, if possible, feedback on a recent successful assignment. We use a box and whisker plot to chart the distributed grades earned across the entire class. Beneath this is a display of the semester plan that students can manipulate, selecting between a calendar view, a list view, a timeline, and a tech-tree display of the semester dates and assignments. These displays also operate as the portal through which students submit their work, identify self-selected groups, record participation, predict their scores, and receive feedback.

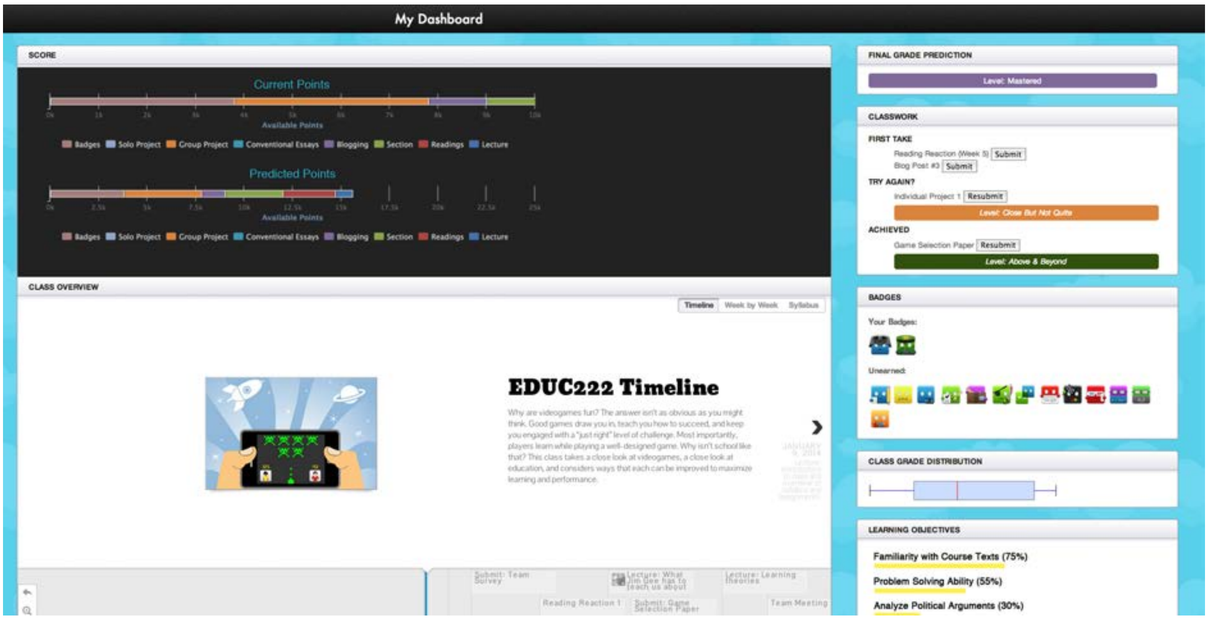

Figure 1: GradeCraft Student Dashboard

The top progress bar serves an informational purpose, but may also have a motivational effect, as preliminary research indicates that this type of display boosts user motivation to complete tasks (Kohler, Niebuhr, & Hassenzahl, 2007). The inclusion of learning objectives, whose progress is tied to achievement within various components of the course, is intended to help students direct their attention to the broader course goals – items that may get overlooked without persistent reminders and representations of student advancement.

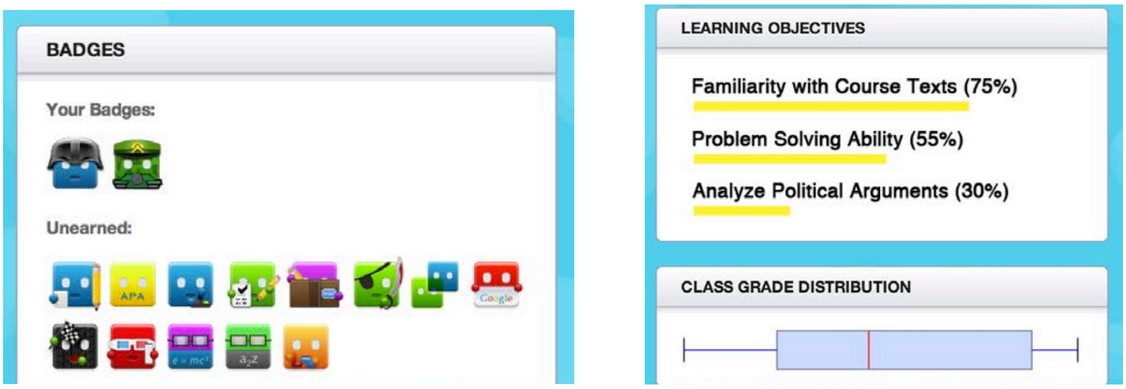

Figure 2: Panels showing student badges, learning objectives, and course grades

Badges are currently being investigated as both a motivational tool and an alternate credential system (Joseph & Global Kids, Inc., 2012). GradeCraft provides tools that allow instructors to create badges, define the criteria necessary for earning those badges, award badges both manually and automatically (when attached to achieving certain levels in assignments), and display back to students the badges they have earned. As we are beginning to study the social impact of badging in the classroom, students are now able to share their earned badges with their classmates. By implementing the Mozilla Open Badges Displayer code (in addition to the Issuer code that allows our students to share their badges beyond this environment) we are also able to allow students to display badges they have earned in outside spaces, highlighting their skills for their classmates and instructors. We anticipate that this new information about their classmates' achievements may have a motivating effect, in addition to establishing an explicit understanding of the distributed skillsets in the classroom, potentially laying the groundwork for more effective group work to be completed.

The Grade Predictor tool allows students to explore "what if?" questions; as they look forward to the semester assignments they can decide exactly which tasks they will work on, and predict how successful they will be in each. Their progress is displayed as a bar that fills in with each additional achievement and is broken down by assignment type to allow the student to visualize the impact of each type of work. Students can strategize effort and achievement, avoid tasks they dislike, maximize work they know they can succeed in, and knowingly take 'safe' risks completing work they are less familiar with. We have observed some students plan to complete many assignments at an "acceptable" level of work, while others decide to do a few valuable assignments at a truly "above and beyond" level. The Grade Predictor display reflects a student's current achievements, and the interface has proven crucial to guiding conversations between the instruction team and students trying to figure out how to recover from a specific mistake, or simply improve their overall course standing. We consider the Grade Predictor to be a key feature within our LMS that builds student autonomy within the course, and provides students with the information to take control over their own success—all within an interface designed to scaffold the creation of achievable individual goals. In the initial implementation of the tool, the Grade Predictor tool was a completely separate interface in the LMS; in response to user testing it has been relocated to the Student Dashboard in order to more seamlessly highlight the tool's functionality for students.

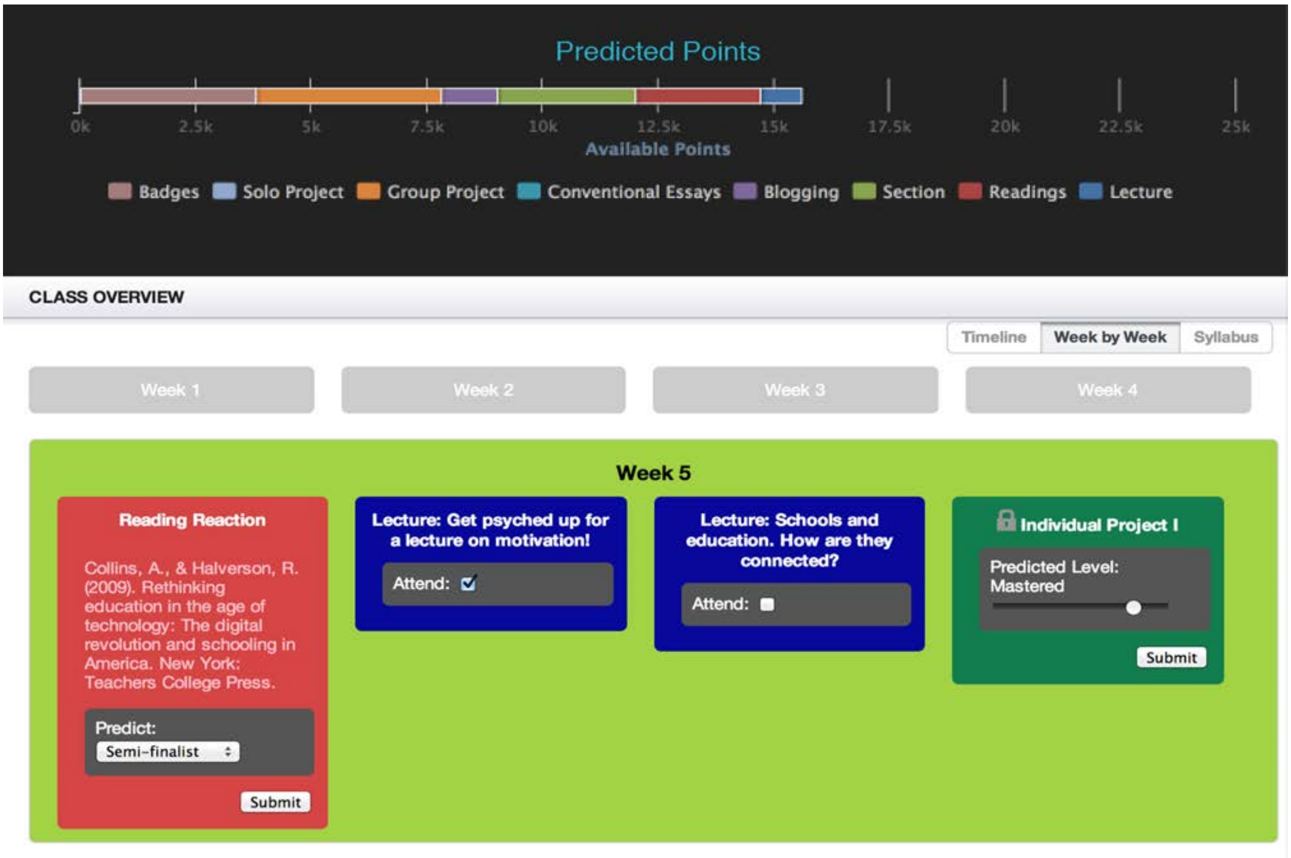

Figure 3: Grade Predictor Tool

In response to student and instructor feedback on our most recent implementation, we have now added an interactive timeline (based on the Timeline.JS work, http://timeline.verite.co/) and will be increasingly allowing students to personalize their dashboards, including dragging and dropping sections of page, minimizing the display of badges and assignments students do not intend to work on, and configuring the presentation of which progress metrics are persistently displayed.

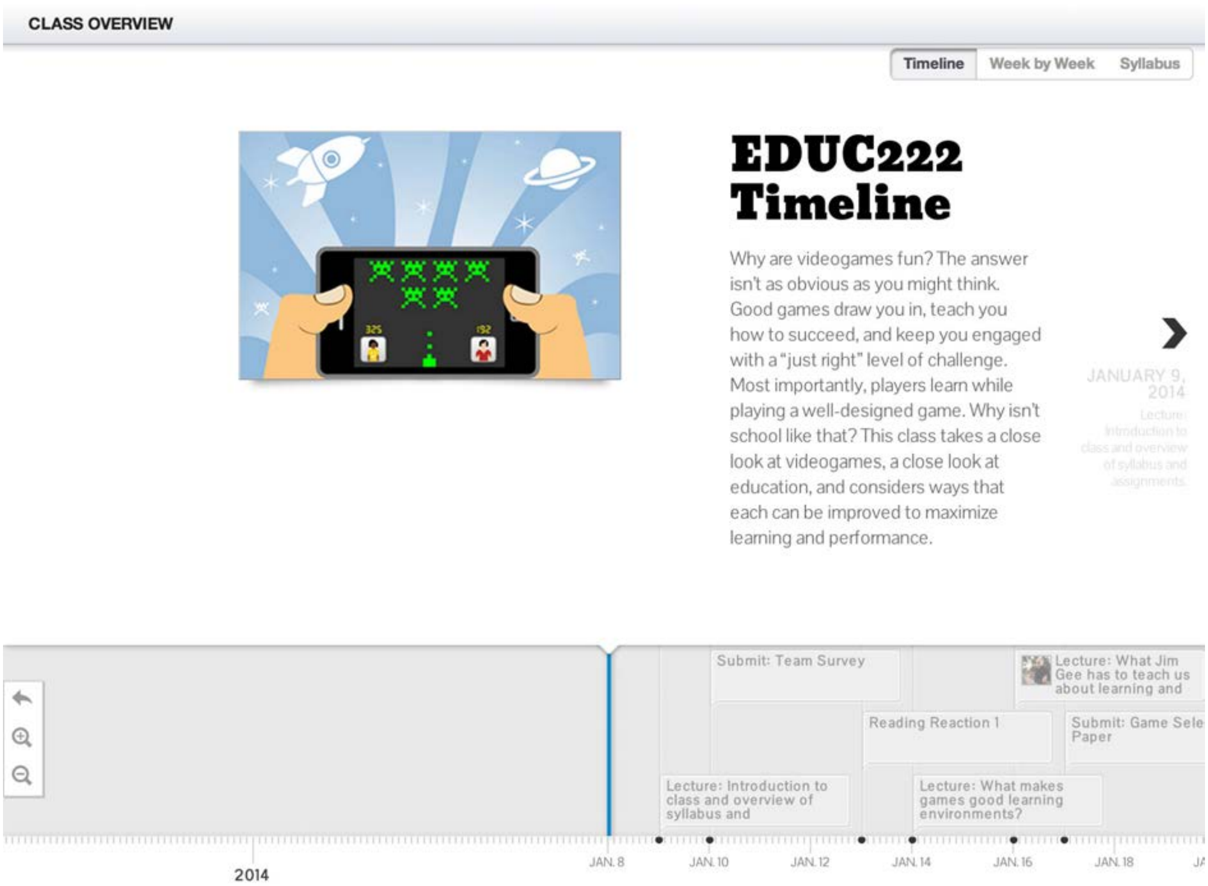

Figure 4: Interactive Semester Timeline

The Instructor Dashboard

While gameful assessment systems are potentially motivating for learners, they are also a formidable task for instructors to execute successfully. Part of the difficulty is related to the change in pedagogical approach; new or different pedagogies require new practices by teachers who are used to organizing instruction and assessment in a particular way. Pedagogies that present more choice to learners and result in a broader variety of representations of learning are more difficult to manage than "traditional" didactic pedagogies (e.g., Crawford, 2000). On the instructor side, GradeCraft makes it easier for teachers to manage the gameful structure of the class itself. This includes providing tools to monitor the progress of individual students and groups of students, to organize and support both collaborative and competitive work, and to provide feedback on assignments that are linked to different kinds of recognition for student work in the form of badges and marked progress towards achieving learning objectives.

The instructor dashboard is designed to help teachers know how their class is performing in a single view. The ten lowest and highest performing students' grades are each visualized with stacked bar charts, each color segment reflecting achievements within an assignment type (e.g., Attendance, Reading Reactions, Blogging, etc.). Instructors can rapidly see what types of work is being done by each student, and isolate which students may be in need of more support. One instructor has reported that this visualization is now at the core of his meetings with his teaching team, as they go through the students occupying these tiers one-by-one to understand how they are progressing through the course. A box and whisker plot is used to capture the overall class performance, displaying the range of achievement as well as situating how the majority of students are doing.

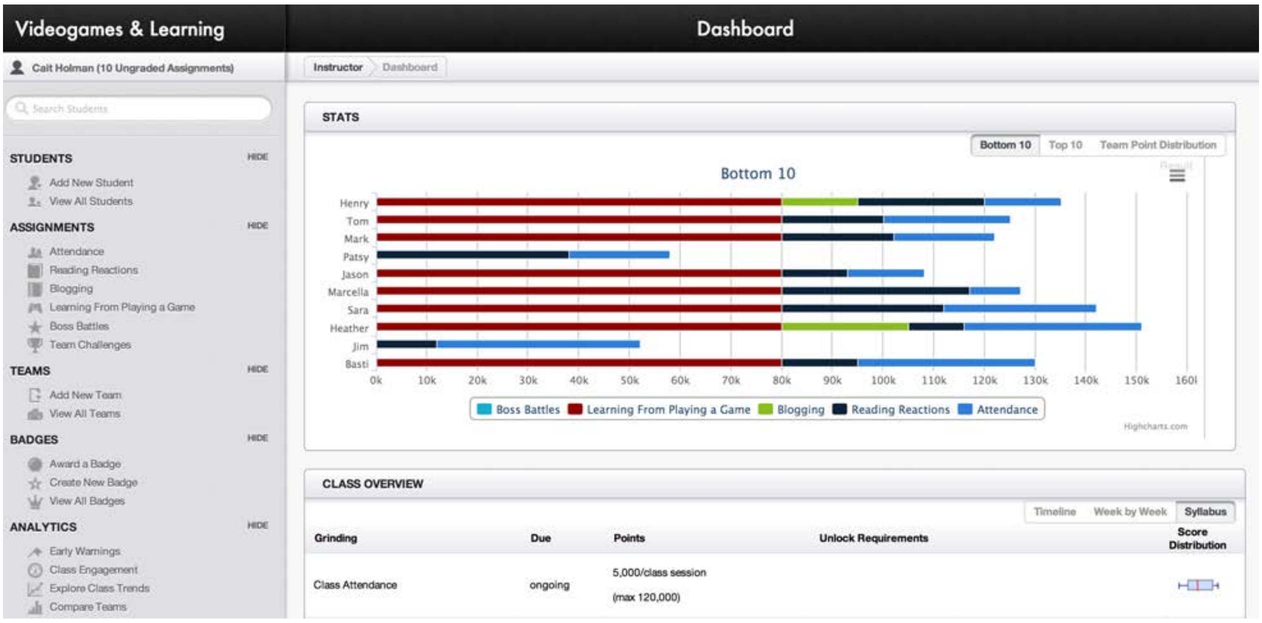

Figure 5: Instructor Dashboard

Grading can be a challenge in any course, but especially so in gameful frameworks given the personalized nature of the assignments themselves, the varied due dates, the likelihood (and active encouragement) of resubmission, and the variety of feedback required, including grades, text feedback, badges, and progress on learning objectives. Asking instructors to independently assess these items, and subsequently mark them in three different parts of the GradeCraft interface, resulted in instructor confusion and frustration. Ultimately the badging system in three different courses was abandoned as a result. We must expect that completing the ‘necessary’ grading for a course will take precedent over the ‘optional’ assessment of items like badges. This means that in order to create a successful course that implements badges in a useful manner, we must include the marking of student progress on all items in a single unified grading form. To achieve this we have constructed a rubric grading tool that allows instructors to define the grading scheme for any assignment, and connect it to specific learning objectives and badges. Instructors can share specific rubrics with the students to better guide their work. After the grading process has been completed, instructors can visualize the overall class performance on each metric in the rubric. We hope that this display will help teachers to better discover skills and content areas where groups of students need more specific instruction to improve their performance.

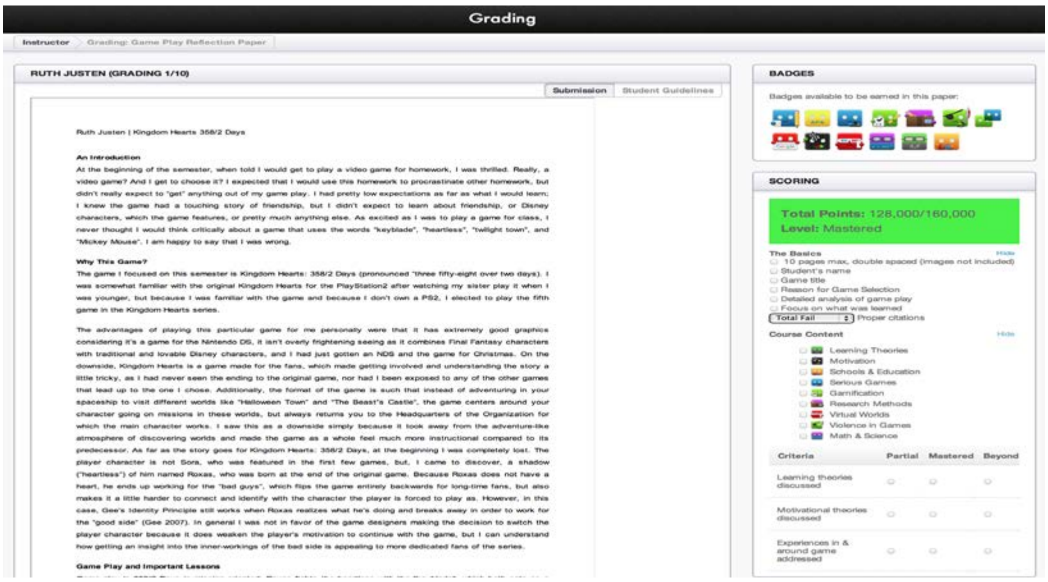

Figure 6: Rubric Grading Tool

Future Directions

Currently we are working on the development of a more-robust data analytics engine that can draw from multiple data sources, including students' current performance in the course, student behavior within the GradeCraft interface, and academic history and planning information from our university records. We will construct data displays based on this data-analytics engine that are both student-facing and instructor-facing. We are particularly focused on helping instructors recognize which students may need more support, and informing students about what behaviors high-achieving students use to succeed.

GradeCraft has thus far operated as a standalone solution, but we have heard repeated requests from instructors that integrating the application with other established solutions would drastically improve their students' experience and their workflow as teachers. We are currently in the process of implementing LTI integration in order to make this possible, and are crafting it so that GradeCraft can be both a plugin to another LMS, or the core LMS that can host other LTI tools.

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Examining a Conceptual vs. a Computational Design on Understanding in a Mathematics Game

Charles Kinzer[1], Selen Turkay[1], Dan Hoffman[2], Dao Chantes[1]
[1]Teachers College Columbia University
[2]University of Illinois at Urbana-Champaign

Abstract: This paper examines the effect of different learning mechanics on middle school students' learning outcomes and motivation in two versions of a mathematics videogame designed to teach the properties of angles. One version was computation-oriented and required players to choose a correct numerical answer that solved an unknown angle. The second version was identical, except that players were required to choose the correct conceptual rule that would apply to finding the solution for an unknown angle. The impact of these two game versions was subsequently analyzed to determine their effect on two dependent variables: learning, and motivation. Results from N=194 sixth and seventh grade students, randomly assigned to play one of the two versions of the game, suggest that the learning mechanics studied affect how much students learn, favoring the computation-oriented game version. Implications of these findings are discussed within the context of educational game design.

Introduction and Background

In education, an important distinction is often made between procedural and conceptual knowledge. Procedural knowledge is the ability to execute action sequences to solve problems whereas conceptual knowledge is implicit or explicit understanding of the principles that govern a domain and of the interrelations between units of knowledge in a domain (Rittle-Johnson, Siegler, & Alibali, 2001). In general, conceptual knowledge is known to generalize to other contexts whereas procedural knowledge consists of action sequences that may be memorized without a firm understanding of the concept (Rittle-Johnson, Siegler, & Alibali, 2001). In mathematics, conceptual knowledge is flexible and generalizable as opposed to procedural knowledge, which is tied to specific problem types (Hiebert & Lefevre, 1986). Given these important properties, the National Council of Teachers of Mathematics (NCTM) emphasizes the importance of students developing a conceptual understanding of mathematics (NCTM, 1989, p.17).

In mathematics classrooms, procedural approaches are often used. However, research has shown that students who learn in a conceptually oriented mathematics classes outperform those who learn in procedurally oriented classes and have more positive attitude toward mathematics (e.g., Boaler, 1998; Masden & Lanier, 1992). Given the importance of conceptual learning approaches and a tendency of teachers to rely on procedural practices, is it possible to create a more conceptually focused learning experience in an educational videogame about mathematics?

Many researchers have been advocating digital games as engaging tools for learning of various concepts, including mathematics (e.g., Gee, 2008; Squire, 2005). Players may learn different types of knowledge in several ways (e.g., through narrative, game mechanics etc.) while they play games (Turkay & Adinolf, 2012). Ideally, the learning aspects of a game should be integrated in a way that they become an integral part of the game play and not merely an addendum to the game mechanic (Kinzer et al., 2012; Plass et al., 2011). This concept also relates to exogenous v.s. endogenous fantasy in educational games (Malone & Lepper, 1978). Exogenous fantasy is when the gameplay is separated from the educational content of the game whereas endogenous fantasy is when the gameplay is connected to the educational content. However, the majority of mathematics-content commercial educational games target automaticity in strategy application through drill and practice rather than focusing centrally on the introduction and development of concepts. In other words, they are more concerned with players' procedural knowledge than conceptual knowledge as it is often challenging to make conclusions about learners' conceptual understanding based on the product of a procedurally oriented mathematics questions. While games in the domain of mathematics aim to motivate students with various external rewards (e.g., points, positive feedback) that may harm intrinsic motivation (Deci, Koestner, & Ryan, 2000), many also fall short in promoting higher order thinking by targeting mostly procedural knowledge gain.

One way to achieve cultivation of conceptual knowledge that can facilitate a balance between conceptual and procedural knowledge may be to design games by utilizing learning mechanics. Learning mechanics may be thought of as patterns of behavior that form the essential *learning* activity that is repeated throughout a game (Plass et al., (2013), see p. 698). Since learning mechanics are concerned with learning as the primary objective, they must be rooted in a learning theory. For example, using a social-cognitive theory, a game might draw on the well-documented instructional practice of peer-tutoring (see Topping, 1988). The specifics of how peer-tutoring is integrated into a game is the business of game designers, but one possibility might be to require players to generate authentic problems to be solved by other players, thus establishing a peer-to-peer interaction. Regardless of the specifics, an effective educational game will use learning mechanics to present to-be-learned content as well as specific user actions (game mechanics) to foster the acquisition of related knowledge or skills (Plass et al., 2012, p. 65).

We examine herein whether implementing different learning mechanics in games, i.e., learning mechanics that focus on either procedural or conceptual knowledge, results in different outcomes. To do so, we used two versions of the same game to systematically alter the learning approach integrated into each version. The first (arithmetic) version uses a procedural learning mechanic, requiring players to solve problems through computation and calculation. In this version, players submit specific numerical answers in order to advance in the game. The second (conceptual) version, is identical in terms of look, feel, and content, but requires players to solve problems through the application of conceptual rules.

Thus, this study explores the following general question: Given game designers' ability to "design the structures and contexts in which play takes place" (Salen & Zimmerman, 2004, p. 67), what is the potential and appropriate use(s) of varying learning mechanics to address learning and motivation? The following, specific research questions are: RQ1: How do differing learning mechanics affect learning outcomes? RQ2: How do students' subjective experiences change as they advance in the game with different learning mechanics?

Methodology

Design and Participants

To explore the above-noted questions, a two-factor study with a quasi-experimental design was conducted. Two hundred and twenty six (n = 226) sixth and seventh grade students were randomly assigned to one of two conditions based on the learning mechanic integrated into the game: conceptual and arithmetic. Due to participants' absence either during the pretest or the posttest, 32 participants' data were removed from the analysis. In the end, 194 participants' data were analyzed across the conceptual version (CV: n = 84; f = 48, m = 36) and arithmetic version (AV: n = 110, f = 54; m = 56).

In a preliminary analysis to examine equivalence between groups, statistically significant age difference were found (M_{CV} = 10.80, SD = 0.41; M_{AV} = 11.92, SD = 0.84; t = 12.19, p < 0.001), but the difference in ages was not a concern as the important factor under study was mathematical knowledge related to angles. However, a pretest determined that there was a statistically significant difference in relevant mathematical knowledge of angles between groups. Thus, as will be shown later, a covariate statistical analysis was used to control for pretest-determined group differences.

An independent samples t-test comparing the pre-test scores (Set 1 and Set 2) of CV and AV showed statistically significant differences. Specifically, students in AV's pre-test scores were statistically different than students in CV (p < 0.001, t = 6.52, M_{AV} = 10.04, M_{CV} = 7.42; p < 0.01, t = 3.19, M_{AV} = 2.13, M_{CV} = 1.37; p < 0.05, t = 2.52, M_{AV} = 1.06, M_{CV} = .7). Thus, an analysis of covariance (ANCOVA) was used.

Procedure

The experiment lasted two days, consisting of two, approximately 60 minute instructional periods. Day 1 consisted of introducing participants to the project, answering their questions, and conducting a 15-minute pre-test on their knowledge of the game's educational content (these related to standards 4.G, 4.MD, 4.OA, 5.G, 7.G, and 8.G in the National Governors Association Center for Best Practices, 2010). The paper-based pre-test consisted of 21 questions. On Day 2, participants were given one, 30-minute play session followed by a paper-based post-test. Day 2 activities took place at the school's computer lab. At the beginning of the play session students were told that the game consisted of six chapters and that each chapter had eight to ten levels. They were instructed to advance as far as possible in the game in the allotted time. During game play, participants worked individually, each at one computer console. Each player was given headphones so they could hear the game's audio, and "scratch" paper for their use, if desired. After thirty minutes of play, students were asked to exit the game. At this point, students were given approximately 15 minutes to complete a paper-based post-test which has the same type but different questions.

Instruments and Measures

Educational Video Game

The educational video game used for this study was *Noobs vs. Leets: the Battle of Angles and Lines*, developed by researchers at the Games for Learning Institute (G4LI), previously shown to be an effective educational intervention (see Plass *et al.*, 2011b). The game is designed to teach angle rules and has a simple story in which players help characters called “Noobs” save their friends trapped in various places on the screen by unlocking paths. The paths are unlocked by solving for unknown angles. The game has six chapters and each chapter introduces the player to a new concept about angles. For example, the first chapter starts with types of angles (e.g., acute, obtuse, right, straight) and their numerical degree values. As players progress through the chapters they are shown and required to use more complex rules and concepts such as complementary, supplementary, and vertical angles. In the beginning of each chapter, players are provided with a short (approximately 90 second) video tutorial about the new angle feature introduced in that chapter. The game increases in difficulty with each chapter.

For this study, two different versions of the game with differing learning mechanics were used. We refer to these as the Conceptual Version (CV) and Arithmetic Version (AV). The CV used the learning mechanic: *Apply Rules to Solve Problems*: Learner selects the correct rule to solve the given problem (Plass et al., 2011). In the AV the learning mechanic is: *Calculate the Correct Answer*: Learner selects the correct answer to the target problem. In the CV, players solve missing angles by identifying the correct rule or concept among several possibilities. For example, to solve the highlighted locked angle in the different versions of the game in Figure 1, AV participants have to click on the locked angle, calculate the answer and select the answer from given choices on the left hand side of the interface. In the CV, participants have to click on both the locked angle and its complementary angle. Then, without a need for calculation, they select the rule from given options that would be the basis for a calculation that would correctly answer the question.

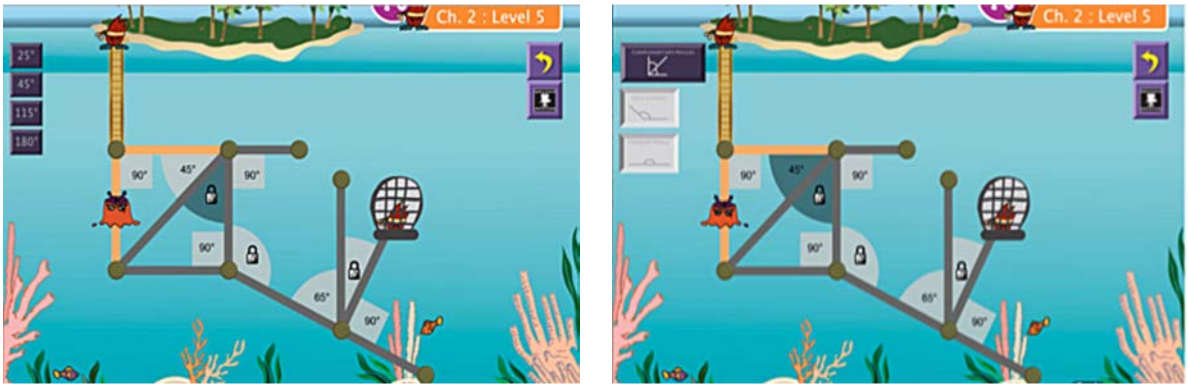

Figure 1. Arithmetic version (left) and Conceptual version (right) on the same game level

Learning Measures

A pretest-intervention-posttest design was used to measure the effect of different learning mechanics on student learning (Dugard & Todman, 1995). To test both prior knowledge and post-intervention knowledge, a 21-item paper-based test was designed by the researchers, containing three sets of questions, which covered the topics on angles introduced in the game. The pre- and post-tests both assessed the participants’ knowledge of angle types (Set 1) and angles within triangles (Set 2).

Measures of Subjective Game Experiences

Motivation was measured using in-game questions presented at the end of each chapter. After each chapter, students answered four questions about their experience before being able to move on. Using a five point Likert scale (1 =”Not at All” and 5 = “Very Much”) students were asked about their subjective experiences in the game. These questions were: 1) How much fun was this part of the game? (enjoyment), 2) How difficult was this part of the game? (challenge), 3) How much do you want to continue playing this game? (engagement), 4) How interesting was this part of the game? (situational interest). Answers to these questions were required in order to proceed to the next chapter of the game. These answers recorded in local log files.

Results

Learning (Pre-Posttest analysis)

A paired samples *t*-test across groups revealed a significant difference for both Set 1 questions ($t = 6.146$, $p < 0.001$) and Set 2 questions ($t = 2.72$, $p < 0.01$) in positive learning outcome from pre- to post-test. Next, we examined learning outcomes by group using an analysis of covariance (ANCOVA) to examine AV vs. CV achievement after controlling for the differences between groups in their pre-tests (Table 1). ANCOVA was required because an initial, independent samples *t*-test comparing the pre-test scores of CV and AV in these two categories showed statistically significant differences between groups for each question set ($M_{AV} = 10.04$, $t = 6.52$, $M_{CV} = 7.42$, $p < 0.001$; $M_{AV} = 2.13$, $M_{CV} = 1.37$, $t = 3.19$, $p < 0.01$).

Results indicate that, after controlling for the pre-test scores, there is a statistically significant difference between groups in their mathematics achievement for Set 1 questions, $F(1, 179) = 12.05$, $p < .001$, *partial* $\eta^2 = .06$ with observed power of .93. Similar results held for Set 2. Results indicate that after controlling for the pre-test scores, there is a statistically significant difference between groups in their mathematics achievement for Set 2, $F(1, 179) = 5.54$, $p < .05$, *partial* $\eta^2 = .03$ with observed power of .67.

		Unadjusted				Adjusted			
	N	M_{SET1}	SD_{SET1}	M_{SET2}	SD_{SET2}	M_{SET1}	SE_{SET1}	M_{SET2}	SE_{SET2}
AV	100	11.12	2.61	2.53	1.55	10.45	0.22	2.35	0.13
CV	83	8.28	2.73	1.59	1.62	9.30	0.25	1.90	0.14

Table 1. Adjusted and Unadjusted group means and variability for post-test scores using pre-test scores as a Covariate

Subjective Experiences

For the motivation related measures, we conducted a MANOVA to measure change over time and the differences between groups. Because approximately 75% of participants did not reach Chapter 4 of the game in the allotted time frame, only subjective experience reports between Chapters 1 -3 were analyzed.

The number of chapters students completed affected their subjective experiences statistically significantly. A doubly multivariate analysis was conducted to examine possible differences between the AV and CV in the amount of change in participants' reports on the subjective experience measures. Assumptions for the test were met (Stevens, 2002). Statistically significant multivatiate effects were found for the main effects of group, $F(4, 105) = 3.22$, $p < 0.05$, partial $\eta^2 = 0.11$ (see Tables 2, 3, 4, 5 for details) and for the chapters, $F(8, 101) = 23.93$, $p < 0.001$, partial $\eta^2 = 0.66$, but not for the interaction between groups and the chapters. This lack of interaction means that the difference between the groups on the linear combination of the four dependent variables is not statistically significantly different from Chapter 1 to Chapter 3. Follow-up ANOVAs reveal that engagement ($F(2, 216) = 3.42$, $p < 0.05$, partial $\eta^2 = 0.03$), interest ($F(2, 216) = 2.08$, $p < 0.05$, partial $\eta^2 = 0.03$), and challenge ($F(1.87, 202.00) = 121.36$, $p < 0.001$, partial $\eta^2 = 0.53$) changed statistically significantly over 3 Chapters. However, the amounts of change in the outcomes were not statistically significantly different for AV vs. CV groups.

Enjoyment

CV participants reported statistically significantly higher levels of enjoyment than AV after each chapter (see Table 2).

	Chapter 1				Chapter 2				Chapter 3			
	M	*SD*	*t*	*p*	*M*	*SD*	*t*	*p*	*M*	*SD*	*t*	*p*
CV	4.37	0.94	3.40	0.001	4.01	1.26	2.21	0.028	4.27	1.13	2.44	
AV	3.76	1.24			3.58	1.40			3.72	1.26		

Table 2. Statistics of the differences between groups on game enjoyment over three chapters.

Challenge

Although CV participants reported higher levels of challenge than AV participants after the first chapter, a statistically significant difference did not occur after chapters two and three (see Table 3), although both groups' perceptions of challenge as shown in their mean scores rose as they progressed through the game.

	Chapter 1				Chapter 2				Chapter 3			
	M	*SD*	*t*	*p*	*M*	*SD*	*t*	*p*	*M*	*SD*	*t*	*p*
CV	2.01	1.14	2.98	0.003	3.15	1.23	1.01	0.31	3.44	1.31	0.91	0.36
AV	1.57	0.96			2.96	1.25			3.23	1.09		

Table 3. Statistics of the differences between groups on felt challenge over three chapters.

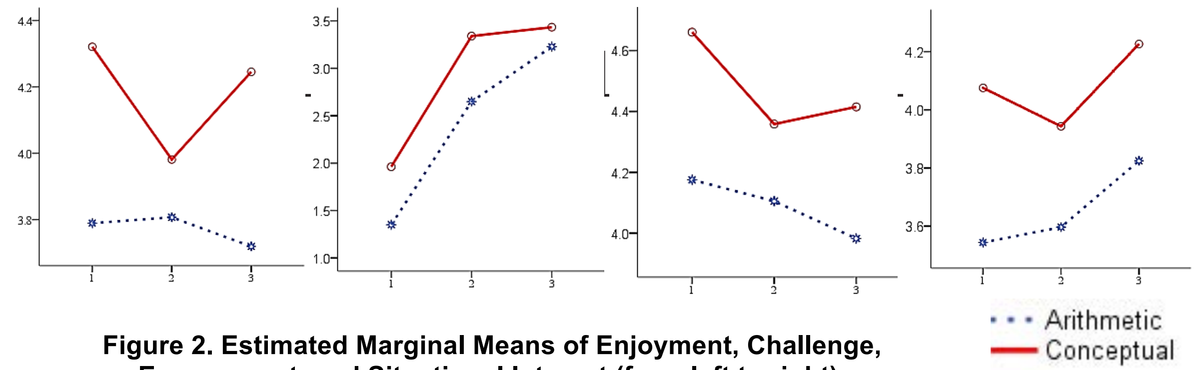

Figure 2. Estimated Marginal Means of Enjoyment, Challenge, Engagement, and Situational Interest (from left to right).

Engagement

Reported engagement was high for both groups. However, CV participants consistently wanted to continue playing more than AV participants did (see Figure 2 and Table 4).

	Chapter 1				Chapter 2				Chapter 3			
	M	*SD*	*t*	*p*	*M*	*SD*	*t*	*p*	*M*	*SD*	*t*	*p*
CV	4.61	0.88	3.65	0.001	4.39	1.11	3.29	0.001	4.44	1.01	2.24	
AV	4.08	1.19			3.81	1.33			3.98	1.13		

Table 4. Statistics of the differences between groups on player engagement over three chapters.

Situational Interest

There were statistically significant differences between groups in reported situational interests after the first and second chapters, but not after chapter three, even though both CV and AV participants reported their highest level of situational interest after the third chapter (see Table 5).

	Chapter 1				Chapter 2				Chapter 3			
	M	*SD*	*t*	*p*	*M*	*SD*	*t*	*p*	*M*	*SD*	*t*	*p*
CV	4.10	1.06	2.86	0.005	3.94	1.36	2.44	0.016	4.24	1.07	1.93	
AV	3.63	1.25			3.47	1.26			4.30	1.18		

Table 5. Reported situational interest over three chapters and statistics of the differences between groups

Discussion

This study examined potential differences in learning and engagement motivation across two versions (conceptual and arithmetic) of the same game, implemented using different *learning* mechanics while holding *game* mechanics constant. Game version had a statistically significant impact on students' learning gains, thus results indicate that games with the same game mechanics and differing learning mechanics can impact outcomes and players' subjective experiences. An interesting result of this study is that even though students in the CV enjoyed the game more, AG participants' achievement from pretest to posttest was higher.

Students in the CV reported higher engagement, enjoyment and situational interest toward the game than students in the AV. Although the CV group indicated a higher challenge perception than AV for the first chapter of the game, this difference disappeared in the following chapters. Positive experiences, as reported by students in the CV group, dropped at the end of the 2nd Chapter, which is puzzling. Future studies may consider conducting short interviews with participants after they complete the game session to investigate further the possible reasons for reported changes in their perceived experience.

In addition to self-report data, future studies will also examine the effect of in-game player interaction time. We can see from Tables 2, 4, 5 that after finishing Chapter 3, students reported an increase in their subjective positive experiences. It is possible that as they play longer, and advance farther in a game, they enjoy it more.

Given game designers' ability to "design the structures and contexts in which play takes place" (Salen & Zimmerman, 2004, p. 67), this research has implications for educators and game designers. Findings call for careful consideration of learning mechanics to maximize players' learning and motivation, inform understanding of the potential influence of different learning mechanics in educational games, and suggest the importance of considering how different learning mechanics may be used in different stages of learning.

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Where Have All the (Educational) Games Gone?

Charles Kinzer[1], Selen Turkay[1], Dan Hoffman[2], Chris Vicari[1], Christian De Luna[1], Dao Chantes[1]
[1]Teachers College Columbia University
[2]University of Illinois at Urbana-Champaign

Abstract: With 91% of children ages 2 to 17 playing videogames at home (NPD, 2011), on average of seven hours per week (Woodard & Gridina, 2000), researchers and game developers are increasingly interested in the poten tial of implementing videogames or game-like environments into classrooms (e.g., see Baek, 2008). However, there are many challenges that prevent the implementation of video games in educational settings (Egenfeldt-Nielsen, 2007, p.63), and many educational games that are presented as under development in academic settings do not reach homes or classrooms. Through analysis of survey-based responses provided by educational game developers, producers, and marketers, this paper examines the barriers and difficulties that impede the development and availability of educational games. Findings indicate that the biggest challenge educational game developers face are finding collaborators to ensure subject-area accuracy and learning integrity. We discuss the implications of this and other findings for the educational game community.

Introduction

The rush to modernize classrooms and improve instructional effectiveness has been a prevailing force since the inception of the education system. However, this push for change is not always embraced by educators and policy makers. Prior to the mass dissemination of blackboard technology in American classrooms in 1801, even this piece of educational technology was viewed with skepticism. Unsurprisingly, a similar path is taken whenever a new piece of technology is introduced into classrooms. Incorporating modern educational technology such as whiteboards, tablets, and educational games are just more recent attempts to improve the classroom experience. Drawing parallels to the resistance to other educational technological experiences (Cuban, 1986), videogame diffusion in schools is sluggish and encounters multiple obstacles from many parties including administrators, teachers and parents (Egenfeldt-Nielsen, 2010).

With 91% of children ages 2 to 17 playing videogames at home (NPD, 2011), on average of seven hours per week (Woodard & Gridina, 2000), researchers and game developers are increasingly interested in the potential of implementing videogames or game-like environments into classrooms (e.g., see Baek, 2008). We operationalize “implementation” as using videogames or game-like environments as part of a school curriculum. Yet, in the not-too-distant past, use of the computer and educational videogames were widely viewed as entertainment, or simply used as rewards for good behavior by educators and adults (Schrader, Zheng & Young, 2006). In short, there may be misconceptions and misunderstandings about the potential of videogame integration, or even how games might function in educational settings (Zheng, Young, & Gilson 2004). Researchers argue that if teacher perceptions toward educational games continue to be informed by negative personal experiences, the state of classroom integration will likely remain unchanged (Schrader, Zheng & Young, 2006). Even though a great deal of research has been conducted pertaining to the anxiety educators feel toward incorporating educational games in their classrooms, little has been done concerning the barriers educational game developers experience when creating or marketing their games. A clear challenge is for educational games to speak more directly to teachers and parents about their potential to increase learning, in ways that incorporate the tools and affordances that teachers view as educational. Incorporating such things into educational games, however, may be a barrier that developers will find difficult to overcome.

Thus, this paper aims to shed light on possible barriers and difficulties that may impede the development and distribution of educational games through a survey study of educational game developers, producers, and marketers. Below, we briefly discuss the surging popularity of using games for educational purposes and review previous studies that have investigated the diffusion of educational games in schools. This is followed by a description of our methods, findings, and a discussion of the implications of our results for the educational game community.

Background

Stevens, Satwicz, and McCarthy (2008) argue it's no longer sufficient to view games merely as motivational, and because of the potential educational advantages games can offer (see Squire 2006; Shaffer, Squire, Halverson, & Gee, 2005), the interest in examining their pedagogical values has exploded. There is a surge of game-related research and a push to try to implement educationally-relevant games into classrooms. Yet, despite scholars who note the potential educational benefits games can offer (e.g. Gee, 2003; Squire, 2011), there exists a great deal of apprehension from educators and a number of glaring obstacles that impede the proliferation of educational games in classroom settings. These hurdles relate to the difficulty of documenting the benefits of game-based learning and finding ways to allow a teacher to explore and test the game. The latter issue, what Rogers (2003) calls trialability, is a primary factor in whether or not a game can be included into curricula.

In addition to difficulties encountered on the administrative side of implementation, issues are also related to teacher usage of educational games in classrooms. For many educators, videogames are unfamiliar media with conceptions of such games ranging from simple arcade games to hyper-sexualized and immensely graphic virtual environments (i.e., the *Grand Theft Auto* and *Call of Duty* series*)* (Rice, 2007). These general perceptions can understandably foster uncertainty about the utility of games in the minds of educators. Even for those educators who have been exposed to wider varieties of games, and educational games in particular, their breadth of exposure still may be limited, detracting from their understanding of the potential gains from games (Schrader, Zheng & Young, 2006). However, there is reason for optimism in that, in terms of the relative advantage (Rogers, 1995) of games, teachers believe in games' motivational capability. In studies by FutureLab (Williamson, 2009) and the European School Network teachers (Wastiau, Kearney, & Van den Berghe, 2009) motivation was listed as a predominant reason for why teachers would use games…with around 25% of all teachers recognizing the motivational strength of games (Egenfeldt-Nielsen, 2010, p. 65).

For games to have a meaningful place in education, changes in educators' perceptions of what games are and what they are capable of is necessary (Schrader, Zheng & Young, 2006). Such an understanding can only be achieved by encouraging game literacy before actual classroom use. As Shaffer (2006) mentions, "the only way you can help young people become a discerning player is to become literate yourself. . . . When you can't read, it is hard to tell whether a book is bad or whether you just don't know enough to read it. The same is true for games" (p.192).

When considering implementation of games in the classroom, a number of issues must be considered. Rogers (2003) mentions that one factor influencing adoption of an innovation is its compatibility within the environment in which it is being implemented. With games, compatibility entails educators using games that work well within the subject they teach. Baek (2008) notes that if teachers do not thoroughly examine how a game may fit into their curriculum, the selected game may not provide the desired educational effects. Time to actually experience a game and determine how it can be related to the curriculum, however, may be problematic given teachers' current responsibilities and workloads (Klopfer & Yoon, 2005). Teachers wishing to use games in their classrooms must often develop alignments to curriculum standards on their own, which can also be a potential barrier to implementation given the time required to do so (Rice, 2007). If a game is not easy to use, or solutions to problems cannot be quickly mitigated, teachers could be reluctant to consider using videogames as a part of their curriculum (Kebritchi, Hirumi, Kappers & Henry, 2009). With this in mind, it is important to also be aware of the difficulties that educational game designers and developers may face to address these concerns.

This study attempted to ask specifically about the effects of the barriers noted in the literature as coming from educators, to examine whether the requirements demanded by teachers are being addressed by game designers and developers. Specifically, we noted that many educational games that were discussed or presented at academic and professional meetings and conferences do not appear to be made available to educators. We wondered where those games, developed by educators and educational game designers and presented to educational professionals, ended up—what were the barriers to availability from the developers' and designers' perspectives, and did these barriers match those presented by teachers as hurdles to overcome for educational games.

Methods

Research design, participants, and data analysis

An exploratory mixed method (qualitative and quantitative) online survey was used to collect data. The survey had branches built into it to allow examination of different experiences with educational game development. For example, participants who stated they had developed an educational game but had never intended to market it were asked a different set of follow-up questions than those who said they had attempted to market their game but failed. Therefore, the number of questions a given participant would answer differed depending on the branches taken during the survey. In total, the survey had twenty-five unique questions. Four used a 5-point Likert scale (e.g., How much effort (time, money, resources) have you and your team put into making the educational community aware of your game?), five were open-ended, (e.g. What general questions or comments would you like to provide to educational game developers?) and sixteen were multiple choice/check-box questions (e.g., What supporting educational materials are available for your game?). The survey is available on request from the author in printed form, although it was administered online using the Professional version of SurveyMonkey (www.surveymonkey.com).

Attendee lists of two popular gaming conferences (Games-4-Change and Games+Learning+Society) were extracted from those conference websites for 2011 and 2012. Additional, personal contacts of suggested respondents were also incorporated into an initial mailing. In total, 386 people were invited to participate in the survey via email invitations and, after two follow-up reminders, 172 participants (~45%) completed it. Of these, 142 (~83%) indicated that they had been involved in the development of an educational game and answered questions related to their involvement and the game they developed. The results reported below are based on the answers from these 142 participants. Participants had multiple roles in the development of the game they selected. A majority of the participants were project leads or principle investigators (45%), and 39% were game designers. There were very few public school educators or administrators (*3%*).

Qualitative data analysis was facilitated by statistical analysis software, SPSS 20, and answers to open-ended questions were coded inductively by creating themes of responses.

Results

What kind of educational games are being developed?

The survey revealed 103 unique games developed or under development. Among these, 57% were completed games, 15% were in beta, and 13% were in alpha stages. In terms of platform, a majority of the games were developed as web-based games (~38%), PC games (~ 30%), or mobile games (~24%). A majority of the games developed were in the subject areas of mathematics and science (~41%), followed by social studies (~8%). Middle school students (~34%) were the main target for educational games developed by respondants in this survey, followed by primary school students (~19%), and high school students (~16%) (see Figure 1).

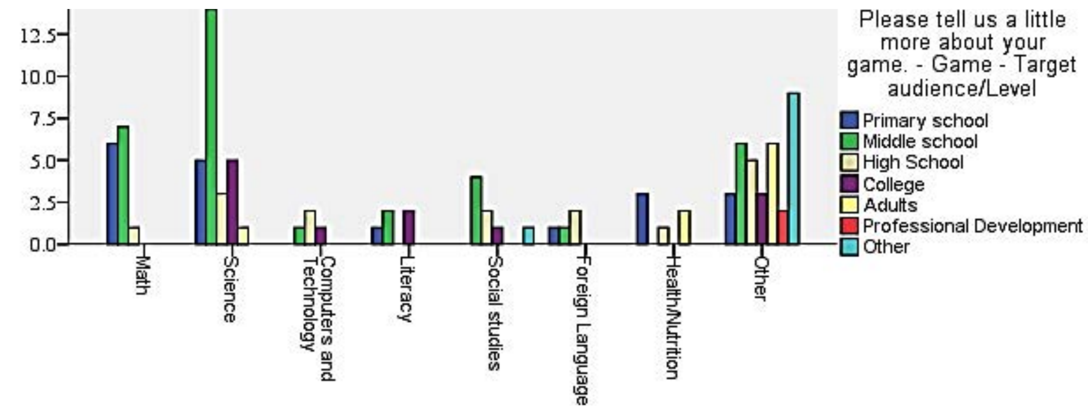

Figure 1. Target audience by target subject area distribution

Games were a result of projects that were: publicly-funded as a federal, or state research project, e.g., by NSF, USDOE, and so on (~23%); a private, non-for-profit research project, e.g., funded by a foundation or NGO (~22%); a university, college or other class project, with or without institutional funding (~12%); a dissertation or master's thesis project, with or without institutional funding (~9%); a commercially-funded development project, e.g., funded by a commercial publisher or the like (~6%); a personal (unfunded) project for one's own purposes (~4%); or other (~3%).

Public availability and awareness of educational games

More than half of the games reported (n=56 or ~53%) were publicly available, and a majority of those were free

(81%) and self-published (~70%); ~11% were available for purchase, and all were available on publishers' websites or could be acquired by contacting their developers.

For those games that are not publically available (n=44 or ~43%), there three main reasons were given: the project needs more time in development or production (~66%), there are funding issues (~23%), and there are technical issues with the game (~21%).

When asked about the level of awareness about their game within the educational community, only 26% of the participants reported that they thought the public was aware of their game, while 35% thought the community was not aware of them at all, and the rest of our respondents said they were not sure about public awareness. The most common responses indicated that our respondents put forth relatively minimal effort at enhancing awareness or providing publicity to the educational teaching community, as noted in the following, representative quote: "We have presented it at conferences and made it available on our web site." However, some participants reported their considerable effort to reach education communities. For example, one project lead said, "I sent out an email to every art and science coordinator in the UK, and [the game] is listed on the TES website - a popular education resource in the UK."

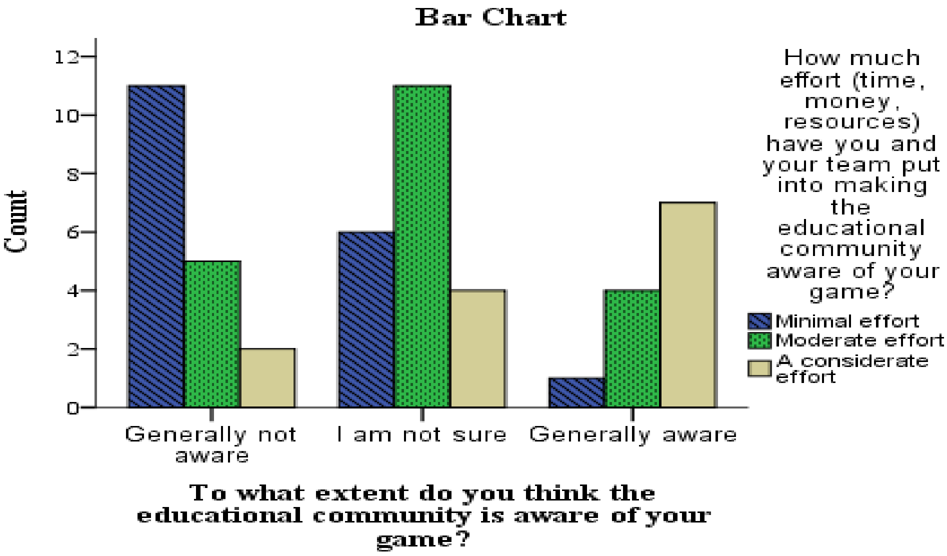

Figure 2. Participants' reported effort to make the educational community aware of their games and how much they think the community is aware.

The most effort (moderate to considerable) to make educational game communities aware of a particular game appeared within games that came from publically-funded, federal, or state research projects (~15%), or private, non-for-profit research projects (~14%). The main venue for promotion of our respondents' educational games was through academic conferences and conducting research in schools. The least effort was given to publicizing an educational game that was the result of a dissertation or master's thesis project (~8%).

Availability of supporting educational materials

When asked what types of supporting educational materials exist for the games they developed, some respondents identified more than one type of available educational supplement. The most common was lesson plans (~22%), followed by game demos (~19%), evaluation materials (~18%), teacher guides (~18%), implementation tutorials, (~16%) and links to State or National standards (~14%). No supporting educational material was provided for 17% of the games. The findings indicate that all games with lesson plans have links to State or National Standards, as do many of the other types of supplementary materials.

Greatest challenges developers encounter

We asked participants to rate the most challenging, the second most challenging and the third most challenging issue they faced with regard to developing their game, other than finances (which we felt would be a common concern and that was discussed in other areas of the survey). To analyze this question, we assigned weights to the responses as follows: three points to items listed as the greatest challenge, two and one point, respectively, to the second and third greatest challenge.

Finding collaborators or resources to ensure learning integrity (1st rank n=16; 2nd rank n=14, weighted score = 46) was the predominant issue identified. This was followed by finding a programmer (1st rank n=14, weighted score = 42), and finding collaborators to ensure subject-area accuracy (2nd rank n=11, 3rd rank n=17, weighted score = 41), which were essentially tied and following by finding collaborators to conduct effectiveness research (1st rank n=12, weighted score = 36). This result was surprising, as we expected that finding a programmer would be the major issue faced by educational developers. The fact that finding collaborators to ensure a game had fidelity to learning was the major issue reported, and that finding collaborators to ensure subject area accuracy and conduct game effectiveness research ranked so highly as challenges for designers speaks to the need for collaboration between educational game designers, educational content-area specialists, and educational researchers.

Participants' open-ended questions and comments to educational game developers

Fifty-two people wrote open-ended responses to this question: What would you like to say to educational game developers? Four main patterns/categories emerged:

1) <u>Learning or educational challenges + game design</u> (*n*=27): These were the related to how design aspects of games should fit with the instructional goals. Here is a representative comment: "*… Too often the game comes first and thus it becomes not as strong of a learning experience (or afford the transfer of skills) as it could be. The game needs to be designed as an engaging experience, but not at the expense of your learning objectives.*" [ID114]

2) <u>Budget/business aspect</u> (*n*=3): These comments highlight some of the challenges that educational game developers may encounter from a business point of view. A representative comment is: *"We had a hard time finding a 'yellowpages' of game developers - both U.S. and internationally-based. That would be a good resource -- as our game is a federally-funded game, U.S. firms are preferred in some of the roles in the project, but as it is a game for developing country players, local firms in the developer role was a logical consideration too.*" [ID66]

3) <u>Commercial games vs. educational games</u> (*n*=9): Some participants commented on differences between commercial games and educational games as well as how commercial games may be used instead of developing lower educational games with lower production quality. A representative comment is: "…*why develop educational games when you can use commercial ones?*" [ID85],

4) <u>Awareness</u> (*n*=8): These comments aim to make educational game developers aware of the process of development. An example comment is:

> The biggest mistake I see is when domain experts try to lead game development projects having no experience. This mistake happens and then a crappy game gets released - or more likely the project fails so badly that no game gets released. Every time this happens the field is hurt because then funders are more leery of funding new games. A negative spiral ensues. The field needs more success stories. The few success stories typically result when a domain expert pairs with real game developers and real education researchers. It is even better when there is a viable commercial angle. A promising development is the venture capital that is going into educational games. These teams are typically not in universities. [ID67]

Participants posed several questions that need to be answered by the educational game community. Some of the questions are: "*What specific characteristics of games make them good carriers of educational content? In what ways are they superior (or are they superior) to other forms of interactive educational software?*"[ID56] or "*How can games make content available to all diverse learners? Those with hearing loss, visual loss, retardation, paralysis, etc.*"[ID12]

A need for an educational game venue/archive

Participants were asked if they would be willing to provide their game(s)' details or a link to their game to share with the education community if there was an open, educational game-resource archive. The majority of participants (64%) said "yes," they would, 32% said "maybe," and 4% said "no." Among those who showed interest in such a venue, 48% provided internet addresses of their games and information about the games.

There was no statistically significant difference in what type of game developer and what development platform or content area) would be interested in such an archive. One of the participants reacted to the idea of such an archive by stating, "*That sounds like a great idea! I'd be happy to provide details of my game once I've developed the improved version and the supplementary materials.*"

Conclusion and Discussion

In this study, we asked ourselves: "where are all the (educational) games that have been developed over the last few of years and presented at popular game related conferences (GLS 2011-2012 and GDC 2011-2012). Results indicate that the educational game community, indeed, is developing an increasing number of games targeting various age groups, as well as content areas. (It is important to note that some participants who indicated that they have been involved in the development of an educational game are also developing other games as well. Although not analyzed for this paper, about 105 additional games that have been completed or under development were reported.) The most popular target age group for these games is middle school students and the most popular content areas are mathematics and science. While a majority of reported games are freely available, little effort is being made to make educational game communities and classroom teachers aware of these games, which is a shame: If teachers and students don't know about these games, how can they play, have fun and learn from them?

We also would like to note that we excluded data from non-developers and those who created materials to make 3rd party, usually entertainment, games available to teachers to use for educational purposes. Sites like "Minecraft Teacher" (http://minecraftteacher.tumblr.com) or "Teach with Portals" (http://www.teachwithportals.com/) are such sources.

While researchers argue that more efforts should be made to raise teacher and parental awareness of potential educational benefits (Baek, 2008), these findings tell another story. We found relatively few educational games to include supporting educational materials—things that teachers say are a hurdle to adoption. As Kebritchi et al. (2009) note, "Although teachers have been mandated to use technology in the classroom, they have not been given the proper professional development to help facilitate this integration." (p.135) Such materials may include: teacher manuals, student activities, integration strategies, assessment guides, lesson and unit plans, and teacher aids (Kebritchi, Hirumi, Kappers & Henry, 2009). Having lesson plans and links to core standards facilitates support and implementation in classrooms. Educational game development communities should be aware of this and develop lesson plans for their games as supporting materials. The development and availability of supplemental materials to assist educators is pivotal to any future adoption of educational games. Such efforts can also help increase understanding of how videogames can be situated within teachers' existing goals and knowledge of learning and instruction (Turkay, Hoffman, Kinzer, Chantes, & Vicari, in press).

The most common challenge educational game developers have is finding collaborators to ensure subject-area accuracy, followed by finding collaborators or resources to ensure learning integrity. This finding calls for efforts from the education and educational research community to collaborate with educational game developers. A strong collaboration between educators and researchers, and educational game developers, is a must for development of high impact games and their diffusion of into schools. Educators and researchers must have training in game literacy, and educational game designers must collaborate with game-literate educational content experts and researchers if acceptance and implementing of games into classrooms is to occur.

As educational game development reaches maturity, our results call for a venue where educational game developers can make their games public, and where both educators (teachers and administrators) and educational game developers can have access to play these games, test their effectiveness, and most importantly, use them to aid students' learning. As Hughes, Greenhow, & Schifter (2006) argue, educators and developers have to combine their knowledge of instructional technology with their knowledge of content and pedagogy to advance the development of sound educational technologies.

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Situated Learning and Mobile Technologies: Connecting Theory to Design

Breanne K. Litts, Garrett W. Smith, David J. Gagnon, John Martin, Jim Matthews
University of Wisconsin-Madison
litts@wisc.edu, gwsmith@wisc.edu, djgagnon@wisc.edu, djgagnon@wisc.edu, jmmathews@gmail.com

Abstract: In recent years, mobile devices have become ubiquitous across our everyday lives and are seeping into informal and formal educational settings. As a response, scholars, educators, and game designers alike have begun to explore mobile platforms as educational tools. In this paper, we hope to provide a vocabulary and framework for this exploration. Our goals are twofold: 1) to consider the design of mobile activities in terms of theories of learning, mapping mechanics on a theoretical platform, and 2) offer a framework to inform future learning design with mobile technologies. We hope this paper adds to the discussion around mobile learning in providing a broad theoretically-driven survey of the landscape.

Introduction

In recent years, mobile devices have become ubiquitous across our everyday lives and are seeping into informal and formal educational settings. Mobile technology has gained traction in education settings due to both its ubiquity and its unique affordances; its mobility allows learning to happen in more situated contexts and its portability brings digital technologies to students in classroom in a different way than desktop computers. In this paper, we explore the distinctive affordances of mobile technologies, particularly in the context of education and learning. Our goals are twofold: 1) to consider the design of mobile activities in terms of theories of learning, mapping mechanics on a theoretical platform, and 2) offer a framework to inform future learning design with mobile technologies.

Mobile learning has largely emerged from a grassroots movement in education as a reaction to the rising ubiquity of mobile technologies. As a result, there are many practical illustrations of how mobile has been used in educational settings, yet there is still a deep need to connect these cases with theory. We turn to learning sciences, sociology, anthropology, design studies, game studies, cognitive sciences, and a variety of other fields to begin to build a theoretical vocabulary around mobile technologies. Additionally, in this paper, we put forth a working framework of mobile learning to help frame understanding and design of mobile projects and activities.

Situated Learning

We take up a *situated* perspective toward mobile learning and technologies. Thus, our assumption is that - in terms of learning - the overarching virtue of mobile is its situative nature. Brown, Collins, and Duguid (1989) make a seminal argument that knowledge is inherently situated, being in part a product of the activity, context, and culture in which it is developed and used. Building on this notion, Lave and Wenger (1991) propose *situated learning,* which identifies the person (or learner), activity, knowledge, and the social world as means through which meaning making happens. From this perspective, the person is transformed into a practitioner whose changing knowledge, skill, and discourse are part of a developing identity - in short, a member of a community of practice. Collectively, these theorists move from a paradigm of abstracting principles to designing concrete learning environments in which learners can build knowledge and make meaning.

By getting learners out into the real world, mobile technologies can ground knowledge real-world contexts and situations. Specifically, place, embodiment, and design are three core dimensions of mobile that can be intentionally manipulated to situate learners in specific contexts - we will discuss these further in later sections of this paper. Squire (2006) refers to these types learning environments as designed experiences; however, we focus here on designed experiences that are possible on mobile platforms from a situated learning perspective.

While situated learning defines our general approach to mobile, it also lends itself to more pragmatic design uses. For instance, we argue that in a given mobile activity or experience the problem or task with which learners engage can land on a continuum from abstract to concrete (see Figure 1). The more concrete the problem, the more accurately it mirrors real-world problems, and thus, the more conducive it is to participation in valuable meaning making practices. From these experiences, learners can then abstract and apply only to return to concrete settings. The fundamental assumption here is that learning happens in situated contexts, so centering activities and experiences around authentic, contextualized problems is vital.

Place in Learning

Naturally, *place* emerges as a core dimension in understanding mobile learning and technologies. The value in mobile is that it *is* mobile and portable, and this transforms learning in distinct ways. Scholars attribute a wide set of meanings to place; thus, there is a lot to untangle when considering the roles of place and space in mobile experiences. In this section, we highlight a core property of place that must be considered in any mobile game design or implementation. Additionally, we identify three general approaches mobile game designers and educators can take up to connect place and learning.

A core property that we must consider in mobile learning is the extent to which the activity is dependent on place. Here we use the term place to mean a physical location. This is particularly important in designing, implementing, and understanding mobile experiences, because it asks: how connected is the activity with the location in which it is happening? We map this relationship onto a continuum with *location agnostic* anchoring one end and *location dependent* anchoring the other (see Figure 1, below).

Figure 1: Place continuum.

One the one side, a truly location agnostic mobile activity is one in where the experience can happen anywhere, regardless of physical location. For example, Angry Birds or DragonBox are mobile games, yet are not tied to a physical location in anyway - they can be played anywhere. On the other side, a truly location dependent mobile experience is one in which the activity is inextricably tied to a physical location. For instance, Foursquare or Belly require users to be in a physical location in order to participate. Using these constructs as anchors, we position other genres of mobile activities along the continuum; field research games that require learners to collect real-world data and situated documentaries that present historical narratives in the context they actually occurred expand the range of how connected mobile experiences are with physical locations. The big takeaway here is that mobile affords learning to happen in a variety of locations, which has fundamentally revolutionized the way in which we understanding education and learning.

Furthermore, designers of mobile games and learning environments must also consider: in what ways can learners connect with place? Here we use the term place as a cultural, social construct. We propose that, in terms of mobile learning, there are three types of connection learners can with place: locational, personal, or critical. More broadly, we extract these styles of connection from three general approaches that function as a framework for understanding how learners can engage with place in mobile activities.

At the most basic level, we see place as a gateway to experiential learning about all subjects. For instance, the creek at the local pond teaches about biology and the neighborhood baseball field demonstrates physics. This view of place gives Dewey's laboratory school its edge, and leads to all forms of situated learning practice. With mobile technologies, we can situate content locatively in the place in which the information is relative. In other words, using mobile devices, we can bring the biology content to the pond or physics to the baseball field. This is the most natural and intrinsic connection mobile technologies have with place - a *locational* connection.

Next, Smith and Sobel (2010) describe as place being a shared thing inextricably intertwined with the idea of community. With this perspective of place, it is impossible to separate a location from a community. To really connect with place, not only means to learn from it (e.g. its history, values, vocabulary, art), but also to begin to take part in its creation. One of Smith and Sobel's (2010) core convictions is that young people should be taught how to become contributors to their communities. From this perspective, mobile technologies are not just used as a tool to get learners out in the world, but also to actively participate in the community that surrounds them. This does not always require that learners venture out to a specific location or place, however, it is still often the case. With a community-based approach to place, mobile technologies afford a *personal* connection with place in the form of community education and involvement.

Lastly, designers of mobile learning environments and experiences can take up a more critical perspective of the connection between place and learning. Particularly, Gruenewald (2003a, 2003b) introduces an unapologetic locative social criticism. He begs us to ponder questions such as: Who holds the most power over the use of a place? Who benefits from a place being understood a certain way? What systems are influencing the design of a place? In this view, not only does the place hold meaning and learners become agents, but the systems of power are explicitly examined. Gruenewald (2003a, 2003b) also asks us to analyze the elements of the community that need to be preserved, transformed, restored and created. With this perspective of place, mobile offers a unique medium through which learners can critically engage with place. This combines both the practical and affective characteristics previously discussed, but identifies a deeper *critical* connection mobile can potentially have with place.

In sum, adopting this connection-based framework of place highlights the flexibility of place as a fundamental dimension of mobile learning. It is important to note that these approaches are not necessarily mutually exclusive, but that designers and educators of mobile learning must intentionally decide which style of connection best suits design goals and learning objectives. Mobile technologies have drastically altered the way in which we relate with place both in terms of physical location and sociocultural, historical communities.

Embodiment in Learning

Place and location are not the only aspects of the physical world that serve to situate our learning and cognition. There is mounting evidence that our entire sensorimotor system affects cognition and learning in complex ways (Wilson, 2002; Barsalou, 2009). According to theories of embodied cognition, our body's interaction in the world shapes how we think and learn, and even abstract conceptual understanding is grounded in our perception and action in the world (Goldstone, Landy & Son, 2008; Barsalou, 2009). Perceptual features of an environment can influence how children perform and understand mathematics, for example, and actions can influence problem solving and spatial reasoning, categorization of objects, and reading comprehension and memory (Landy & Goldstone, 2007; Thomas & Lleras, 2009; Smith, 2005; Glenberg et al., 2004). Because of this, some researchers recommend that, rather than focusing solely on "abstract" knowledge as often occurs in classrooms, learners should be offered opportunities to co-opt perceptual processes to aid in tasks that require abstract reasoning (Goldstone, Landy & Son, 2008).

Because of this deep interaction between perceptual and conceptual processes, it is important to understand mobile's unique affordances of perception and action and how mobile technologies may uniquely provided embodied experiences that ground learners' conceptual understanding in the real world. One useful place to start is with Milgram et al.'s (1994) virtuality continuum (see Figure 2). When real-world environments are paired with digital media, one important dimension to consider is *how much* of the real vs. virtual environment the user is encountering. On the one end of the continuum, the the environment the user encounters is primarily real, on the other end primarily virtual. Anything in the space between entirely real and entirely virtual is considered to be *mixed reality*, while environments that are primarily virtual are considered *virtual reality* and those that are primarily real are considered *augmented reality* (Milgram et al., 1994). Many current mobile games fall into the space of augmented reality. Even within this space, it is sometimes helpful to consider how heavily the real-world is augmented with digital media (Klopfer, 2008). For example, camera-based augmented reality game where digital media is constantly overlayed on top of the real world would be more heavily augmented than a location-based AR game in which digital information appears at a only appears at a location under certain conditions. Mobile technologies allow for some unique designs that incorporate aspects of the physical world; built-in gps systems allow for location to be incorporated into designs, cameras allow for image detection and the overlaying of digital information onto a real-time view of the world, and gyroscopes allow for movement tracking.

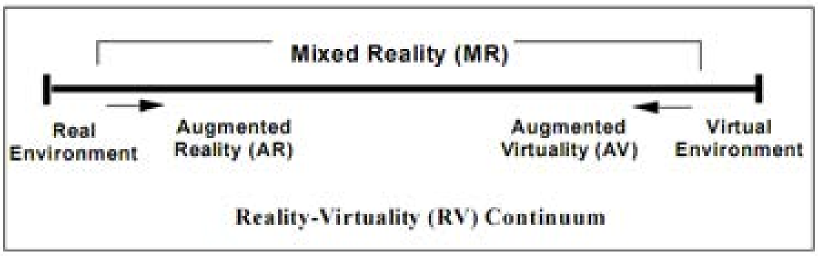

Figure 2: Reality-Virtuality continuum, from Milgram, Takemura, Utsumi, & Kishino (1994).

Though thinking about how much of the real world is incorporated into a mobile game can help us to categorize different technologies and designs, it does not tell us much about the user's experience, and what the affordances of the technology are for situating learning. For this, we should consider *what aspects of perception and action* are incorporated into the player's experience with the game, particularly what perceptual modalities and and specific types of action are utilized in the game and how that may shape experience and learning. The perceptual properties of representations used in mixed reality environments can greatly affect the user's interaction experience (Manches, O'Malley & Benford, 2009). Mobile devices support different types of interactions across the visual, auditory and tactile sensory modalities. Of these, most mobile games currently focus on the visual modality, requiring the player to view the screen to interact with the game. Other games, however, are primarily auditory, where the user is given audio feedback based on their interactions with the world. For example, in the fitness game "Zombies, Run!" (see Figure 3), players jog while being chased by virtual zombies who they can hear through their headphones. Most mobile devices have limited tactile feedback (generally only a vibration), so current mobile games may incorporate tactile feedback but generally don't focus on it.

Figure 3: "Zombies, Run!" mobile augmented reality game.

Mobile games can also incorporate a player's physical action into the game design in ways that are unavailable with other technologies. Through the GPS and compass, mobile devices can detect a player's movement in space, and with the gyroscope and accelerometer can detect body movements as well.

Finally, we should pay attention to *how* the combinations of physical and digital elements across multiple sensory modalities and forms of action occur in mobile activities. The precise couplings of elements of the real world with digital information affects the player's experience and may shape learning. Some researchers stress the importance of the relative *locations* of the physical and digital representations in mixed reality environments. For example, Price, Falcão, Sheridan & Roussos (2008) list three levels of different spatial locations of digital representations in relation to real-world objects and actions triggering the digital effect: *discrete*, in which the digital representation is located separately from the input device; *co-located*, when the input and output are contiguous and the digital effect is directly adjacent to the artifact or action; and *embedded*, when the digital effect occurs within the object itself. In augmented reality games, this locational property can often be described as the player either looking *at* the device, separate from the real-world (discrete), or *through* the device to see the real-world with digital information overlaid on top of it (co-located). For example, in the game Dow Day, a situated documentary where players act as reporters to understand an important historical event on campus, portions of the game include a map that is discrete from and a video that's co-located with the real-world space (see Figure 4). The relative locations of digital representations to real-world objects, actions and environments can shape the way learners' understand the relationship between the the digital representations and the real world as well as their interactions with each other in the environment (Falcão, Sheridan & Roussos, 2009).

In addition to *locational* relationships, *representational* relationships may be an important consideration as well. For example, how abstract or concrete are real-world places represented visually on a map? Finally, how the relationships between physical and digital elements may stay constant or change *over time* may be important to consider. A design where the same actions in the same places lead to different results at different times (based on experience or objects collected) may lead to a more compelling and engaging activity.

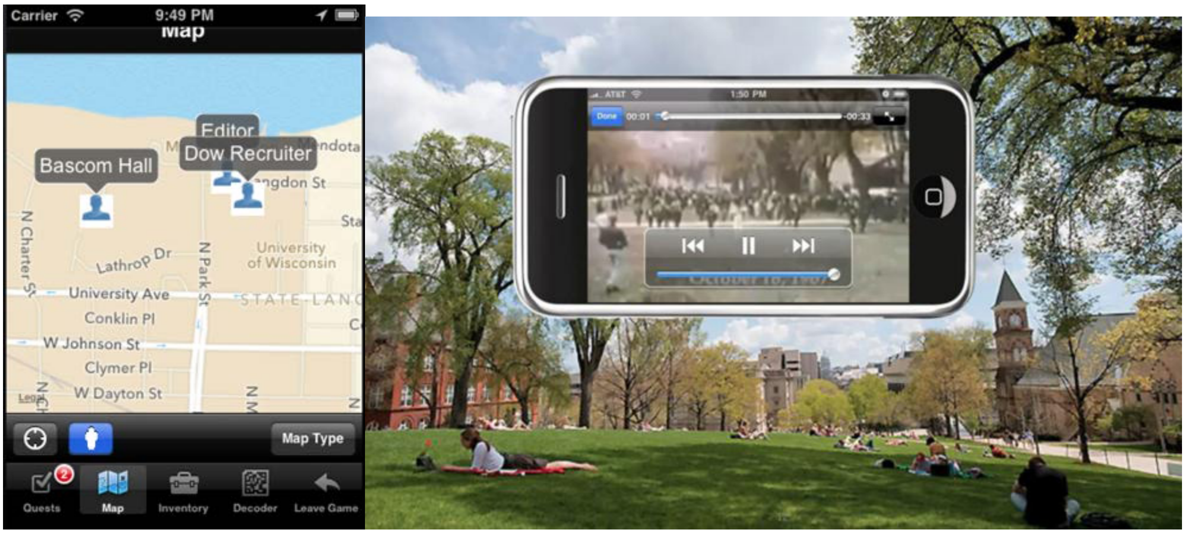

Figure 4: Map and video view from mobile, situated documentary “Dow Day”.

Design

Papert (1980) explains that this working out of ideas through the creation of external, shareable artifacts is a particularly meaningful, situative style of learning. Thus, mobile experiences designed by learners themselves offer a remix of traditional conceptualizations of learning environment. Open source, easy-to-use design platforms have opened the door to practically engaging learners in making the same types of decisions game designs have made.

Given the inextricable connections mobile has with place and the physical body, crafting these activities can be particularly powerful and offer opportunities for learners to reflect on their own learning in ways other technologies do not afford. For instance, Mathews (2010) had his students design their own mobile games to engage with contested places in their city. This means with which students were able to engage afforded a unique platform for students to connect personally with their local community. Another example of how designing with mobile transforms learning is through the use of primary sources to (re)create historical narratives and events, so that they can be experienced in the place that they actually occurred (see Dow Day above as an example of this type of mobile activity). Both of these examples point to important affective and intellectual connections that learners can make through the design process.

Implications

Ellsworth (2005) argues that experience comes prior to and is crucial for building understanding, and that, “the qualities of an *experience* of learning are crucial to *what* is learned.” (Ellsworth, 2005, pp. 18). Thus, in order to design learning environments in which learners actually *learn*, we must intentionally craft designed experiences (Squire, 2006) of quality. Additionally, the *what* that we want learners to understand mutually informs the way in which we design the learning experience.

Given the mobility and portability of mobile, integrating it into learning environments brings to light several design implications that are not present with many other media. There are unique affordances mobile offers learning, and the frameworks we presented above shed light on many of the decisions designers of mobile learning environments must make. Specifically, both the content and learning goals should drive the design of mobile learning environments. For instance, when building a mobile tour of a university campus, the designers must address questions like: do we want users to have to physically walk through the campus (location dependent)?or do we want users to have access to the tour remotely (less locationally dependent)? Taking up the frameworks we have put forth here, affords a vocabulary with which to talk about these decisions, but more importantly a lens through which to manage and organize design decisions specific to mobile.

Though there is a good deal of research emerging from the different theoretical traditions we draw from in considering mobile learning (i.e. situated learning, place-based learning, and embodied cognition), research on how these theoretical traditions translate into mobile learning designs and how those design decisions affect learners’ experience and understanding is only beginning. We hope this framework adds to the discussion in providing a survey of the landscape.

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Fantasy Wrestling as a Site of Competitive Fandom and Connected Learning

Crystle Martin, University of California, Irvine, 4010 Humanities Gateway, Irvine, CA
crystle.martin@gmail.com

Abstract: This paper explores *Over the Ropes,* a fantasy wrestling federation (FWF) that is part of the larger WWE fan community called the *Wrestling Boards*. Although more like a text-based RPG than traditional fantasy sports, it does carry the hallmarks of competitive fandom, including learning, play, and engagement as described by Halverson and Halverson (2008), just as more traditional fantasy sports. This paper explores a history of wrestling to underline the cultural importance of wrestling and then orients the activities of the FWF *Over the Ropes* as a competitive fandom and an example of connected learning.

Introduction

Professional wrestling traces its roots back to the nineteenth century (*Modern Wrestling*, 1895), and has thrived as a major pastime in North America for the past 30 to 40 years and in Japan for the last 20 to 30 years. WWE (World Wrestling Entertainment) is now the largest professional wrestling promotion group in the world. Professional wrestling continues to carry a cultural stigma of being decidedly lowbrow, much like video games (Sammond, 2005). Both are drawn into conversations in the media about their use of vulgarity as means of entertainment and are seen by many as places devoid of cultural value and as educational wastelands. But just as in the vast genre of video game entertainment, professional wrestling offers those who participate in it a variety of educational and culturally relevant experiences as will be touched upon in this paper.

This paper begins by introducing a history of professional wrestling to situate the present study. Next, I draw on data collected from an eight month ethnographic study of a wrestling community to provide an in-depth description of the FWF and illustrate how its competitive fandom operates. The paper closes with an analysis of three principles of connected learning which are strongly exemplified in this space.

History and Literature Review

Professional wrestling is, for many people, an enigma: it is a hybrid – part athleticism, part theater, and dubbed “sports entertainment.” The evolution of professional wrestling to its current state is not known to all and will be described briefly below. Ball (1990) describes the difference between amateur and professional wrestling.

> That branch generally referred to as “amateur wrestling” provides a forum where, true to tradition, competing schools are represented by individuals who symbolize the positive characteristics of strength, skill, strategy, and adherence to the rules which the school claims to own. The second form is the relatively new phenomena of “professional wrestling.” Because the opponents have no explicit ties to schools, countries, or other significant groups, wrestlers are free to take on identities of persons or groups both within and outside their immediate society. The identities assumed by wrestlers and the alliance formed by them offer a rare opportunity to observe, on the one hand, the nature of stereotypes held by the organizers, the wrestlers, and the public, and on the other, the interests of the public revealed in the need for explicit stereotypes (pp. 3-4).

Due to the slow pace of standard wrestling at the professional level, professional wrestlers have been working off scripted routines since the 1930s (Ball, 1990). Fans did not like the slow pace of wrestling but were also upset when they found out that wrestling had been scripted to increase the pacing and excitement. Wrestling was one of the original broadcast sports due to its format of bouts which worked well for television advertising but lost favor in the 1950s because it did not fit the model of the 1950s family ideal. As wrestling progressed through the decades and reemerged on television in the 1980s it began to more heavily incorporate melodramatic elements.

Through a comparison to soap operas, Jenkins (2005) refers to professional wrestling as masculine melodrama. Ball (1990) states that the competitive elements are secondary to the drama before and after the match, although interview data from the present study suggests that both competition and melodrama are central to fan’s investment in the interest. Mazer (2005) views professional wrestling slightly differently than Ball and Jenkins, creating a more nuanced approach to the idea of wrestling as melodrama:

> Professional wrestling is at once like life and like a lot of other things, theater and academia included: real and fake, spontaneous and rehearsed, genuinely felt and staged for effect, prodigious and reductive, profoundly transgressive and essentially conservative...Like Barthes, I frequently find the ecstasy of wrestling's rhetorical and metamorphic possibilities irresistible. Unlike Barthes, however, I have come to believe that what professional wrestling is most like is professional wrestling, (pp. 84).

Professional wrestling is in a category all on its own.

> Because wrestling "gives people what they want", rather than adhering doggedly to any trite ideals of sportsmanship and fair play, wrestling is more reflective of public ideals and values than other sports... wrestling had few known rules--and these are rarely followed. Since rules are seldom enforced, this allows wrestlers to "read" their audience fabricating ritual drama at the audiences demand, (Guaranteed Entertainment, 1948: 51-52).

Wrestling fans appreciate the nuances of the entertainment they watch. "To know the rules by which the game of wrestling is played, not just the names of the moves, but the way the wrestling event is constructed by promoters, is to know how the game of life is played. Whether in the arena or in magazines and on the Internet, fans love to display their expertise. They are 'smarts', not 'marks'" (Mazer, 2005, pp. 75). They display this knowledge to each other through the many means of communication available, including social media (e.g., Facebook and Twitter), YouTube and Tout videos, forums, and wikis. These communication methods are also used to find peer groups who share WWE interests that, for adults especially, are not always readily available in the physical world. A more engaged level of participation in this fan community is to engage in one of the many fantasy role-playing games that are available to fans worldwide.

Fantasy wrestling is generally carried out in a text-based RPG format. Players develop their own characters and decide how the character looks; signature moves; whether he or she is a heel, face, or tweener (i.e., bad, good, or neutral/ambiguous, respectively); what their back-story is; etc. Sometimes the communities make wrestling promotion cards for their players. Each fantasy wrestling group has their own rules specific to the group, decided either by the person running the group who is known as the booker, much like a game master in a tabletop RPG, or by consensus from the group. Players need to understand the intricacies and nuances of wrestling in a sophisticated way and, as Mazer (2005) discusses, this requires knowing more than simply the names of the moves. They have to master the lore and discourse embedded in the wrestling sport as well as be able to create and maintain a persona that is congruous with the type of wrestler they described on their wrestling card. Players also have to be able to switch between personas fluidly while playing, interacting both as themselves and their characters.

Methodology

The data in this paper is part of a larger body of research on the profession wrestling fan community, the *Wrestling Boards.* This is an ethnographic study that employs a combination of observations of the online community and interviews with participants of the community. Observations lasted for eight months, from October 2012 to May 2013, and consisted taking fieldnotes on the conversations within the forum. Twenty-five interviews were conducted with participants in the community. Interviewees were solicited for openly on the forum as well as selected for their participation. The interviewees ranged in status and amount of participation on the forums, as well as what areas of participation on the forum, most interviewees were between 16 and 22. The interview protocol for these interviews were based off a base set of questions exploring connected learning (Ito et al., 2013) generally in online communities and then modified to fit the *Wrestling Boards* community taking into account how the community functions and what specific aspects of the community would be most poignant to explore. Interviews were conducted through chat or the private message system on the *Wrestling Boards*. The interviewees were also followed on the message boards to triangulate data from their interviews as well as to create a well rounded picture of participants and their interaction with the community. This community was very open and willing to talk about their experiences with their wrestling fandom, participation in the forum, and the fantasy wrestling federation, despite the fact that many faced social stigma in their community stemming from their interest in professional wrestling.

The interviews and fieldnotes were analyzed using an *a priori* qualitative coding scheme based on the connected learning principles (Ito et al., 2013) which can be seen in the Table 1 below. A description of the fantasy wrestling federation with this community, based on observation and interview data, appears below.

Connected Learning Principle	Subcodes
Interest Powered	-Invitations/exposures to interest -Information/knowledge seeking -Developing/seeking relationships centered on interest
Peer Supported	-Peer identity/interaction -Compliments and put-downs -Circulation and sharing -Resources sharing and trades -Inspiration and motivation -Feedback and help
Production Centered	-Production tools and opportunities -Seeing under the hood
Identity and Transitions	-Consequential transitions and role changes -Reputation management
Academically Oriented	-Recognition in school and academic identity -Career opportunities -Curricular forms of learning/content
Shared Purpose	-Community/social regulation -Collaboration/joint activity
Openly Networked	-Recontextualization and reframing -Mediational artifacts

Table 1: Connected Learning Coding Scheme

A Closer Look at the Fantasy Wrestling Federation

As mentioned previously, the studied fantasy wrestling federation (FWF), *Over the Ropes,* is part of the larger professional wrestling fan community named *Wrestling Boards.* It is an international community with members across the United Kingdom, Northern Europe, North and South America, and Asia. A majority of participants are between 16 and 25. It is a mixed gender community with anyone welcome to participate, although there are more males than females currently participating. The *Wrestling Boards* community has about 2000 members, but only about 100 participate in *Over the Ropes* with about 20 characters participating in a season of shows at a time. *Over the Ropes* is in its second iteration having just created a new universe about a month before data collection began, after several seasons of the previous universe, with each season lasting about four months. The entire FWF has been active for a little over a year.

At the beginning of each season, the booker puts out a call to the community for characters. Anyone is welcome to submit a character. The character submitted must be fully fleshed out including a developed backstory, information about the type of wrestler including signature and finishing moves, and must give a physical description of the character. Some participants use images to augment the physical description or to give examples of the attire. The booker decides which characters to hire, that is which characters are accepted to play in a current season, and asking for revision to the initial character to make the character a full description based on the template if necessary. The booker then creates wrestling cards for each character with the images supplied by the player, these usually come from pictures of actual wrestlers or bodybuilders while some use the character builder in the WWE videogame to design their own character. Players also create managers, interviewers, and referees who all function in the storyline.

After the list of wrestlers for the season is hired the booker begins the process of setting matches. Each week's show usually consists of several matches, ranging from one-on-one, to tag team, to free-for-alls. A preview card is posted on the forum at the beginning of the week and the players are supposed to participate in that thread, as well as rate the previous week's show, to gain points for the next week. The quality of the post as well as the quantity plays a factor in whether the player gets points to win their match. This means that the players, in kayfabe (i.e., in character), create feuds with other characters, especially those that they are matched with in the preview card. The feuds created by the players are woven into plot lines by the writers, who are community members with interest in creative writing and good grammar. The written show, sometimes up to 85 pages for one week, is put up for everyone to read. The community is then asked to rate the week's match for quality of writing, creativity, depth of story, and spelling and grammar using both writen feedback and rating on a scale of 1 to 5. This feedback is considered and used to enhance the next week's match. After that the next week's preview card is posted and the cycle begins again.

Analysis

Players take pride in their ability to feud, develop rivalries, and create interesting storylines between their character and a rival player's character. Zach, a 17 year old from Europe, describes it like this, "I like having your own character and making him/her the way you want to be. I also like the fact that now how active you are helps with how your character performs. I've never seen the forum so active and it's just a lot of fun posting in character and typing up long posts and such telling off other wrestlers. Kind of makes you feel good." Shared purpose, a principle of connected learning (Ito et al., 2013), is a foundation of the functioning of the FWF. Again, Zach describes it like this, "I'd like to think that I work a comedian/snarky personality but I will get serious as well. I really look into *Over the Ropes* and try to help them improve it by writing reviews of their work so they can improve," adding that improving the writing and the quality of the show makes the entire community better. There is a shared purpose around an interest in this community and it is central to its energy and function as a place to improve skills.

The community is careful to distinguish play from real selves to create a safe space for everyone. Some players will post as their characters and then post as themselves under spoiler bars or by using /kayfabe to indicate when they have stopped talking in character. This practice is especially common when the interaction between two characters is getting heated and turns personal. The community enforces standards of conduct, so actually verbally attacking another community member would be unacceptable behavior. Maintaining community standards is a feature of the shared purpose principle. *Over the Ropes* and the *Wrestling Boards* use enculturation, as well as moderation, to enforce community norms. Crayo, the 19 year old founder and administrator from the UK, describes moderating arguments like this, "it's not like real-life arguments when most of the time there is a right or a wrong, it gets heated very fast online. The biggest challenge I face is keeping both those members happy and dealing with it where both members are satisfied. Sometimes it's an impossible task and I have banned members, but more often than not you help them 'make up' or you show them how to ignore each other."

The community is, like many fan communities, interest powered. The community members come to the *Wrestling Boards* and *Over the Ropes* because they are looking for community that shares their interest, many of them not finding that in the local physical community. Jose, an 18 year old from Europe, described his enjoyment of the community this way, "For someone who doesn't know wrestling fans in real life it is an easy and fun way to talk WWE and just have fun on the forum. The people were great from the beginning and were very open." Zach reiterates this, "It's nice to be on the forums because everyone loves WWE and likes to discuss it. It's like having that one friend who you can always relate to. Instead of a friend I have a whole forum to talk to about it." Again, Maria, 16 years old from the Philippines, talks about why she went in search of an online community, "Oh, it's not really popular in here. They actually think of me as a tomboy, 'cause they associate wrestling to guys." These participants, like many of my other interviewees, have the interest but no local community. Bret, 28 years old from the United States, summed up the role of interest in participation, "[Participating in the *Wrestling Boards* and *Over the Ropes* is] a chance to interact with people that have similar interests. To express my feelings to people that understand them."

The *Over the Ropes* community is also a production-centered. Maria, who has participated in *Over the Ropes* as a writer, "wrote for a while. [But now is] more of the checker, seeing if the shows were good and what things are lacking or wrong. I give my opinion about their [other participants] work/ideas, and I try to do requests." The creation of the show from start to finish is a major investment of the entire community. Rhashan, a 19 year old from the United States, emphasizes how his production is of a higher level than other community members, "I don't give much feedback on *Over the Ropes* aside from the writing because no one else really does *Over the Ropes* like I do, to the extent of shooting real promos." Mike, an 18 year old from the United States and one of first writers for *Over the Ropes*, describes his interest in the production aspects of the FWF, "To be honest, creative writing has always been something I have been fond of for awhile now. I was very good at it in high school so my teachers say. When the Federation was thought of, I knew right then I wanted to be a part of it. Since the federation needed writers, getting into it was just as simple as submitting a creative simulated match segment, or a backstory of a character you wanted to be featured in the show. Now that it has grown so much more; to become a writer, you must have been a member on the forum for at least 2 months, and have high quality posts and good grammar. You still also submit a creative writing piece."

Conclusion

The FWF offers members of an interest-powered community the opportunity to come together and extend the means in which they are able to enjoy WWE. It also provides them the means to become producers instead of just consumers allowing participation (Jenkins, 2006), as well as to help them develop and use a wide range of 21st century skills (Partnership for 21st Century Skills, 2009). From interviews conducted with the community, members perceive some of the learning benefits to include argumentation skills, accepting multiple points of view, collaboration, mentor and apprenticeship, as well as more traditionally academically oriented skills like improved creativity in writing, information seeking, and improved spelling and grammar. Similar learning experiences have been seen in the online communities of video games (Martin, 2012; Martin & Steinkuehler, 2010; Ochsner & Martin, 2012; Steinkuehler, 2011; Steinkuehler & Duncan, 2009). Each member gets to express their creativity and their vision for their character through the character card as well as practice and potentially improve their graphic design and technology skills at the same time.

This community also enables the players to use this environment as a point of connected learning (Ito, et al., 2013), tying their leisure space (interest-powered), their school space (academically oriented), and their peer space (peer-supported) together to support their goals. Mike, a writer for *Over the Ropes* as mentioned above, had a long-standing interest in creative writing. He was able to meld his interest in creative writing with his interest in wrestling. His writing was encouraged by his teacher and he plans to study creative writing as his minor in college. Beside the educational benefits of participation, winning matches offers its own rewards within the community. Winning brings status and reputation to the player because they demonstrate a high level of domain specific knowledge related to professional wrestling. A variety of "levels" of wins are available ranging from a single match to winning a title belt, just like in the real professional wrestling matches. The more matches a member wins the higher their status can climb in the community. The FWF offers members a variety of benefits for participation, social and learning related.

Over the Ropes offers its participants a safe space to explore their interest-powered fandom. The nature of the community creates production-centered activity and an atmosphere that supports members working toward a shared purpose. This competitive fandom (Halverson & Halverson, 2008) encourages fans to display their expertise, use strategy and creativity in tandem, participate in a discourse, and learn and develop life, academic, and social skills. *Over the Ropes* takes a new perspective on competitive fandom, is a powerful tool for its participants, and offers its participants all the benefits of both a competitive fandom and a connected learning environment.

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Fantasy Football:
A Touchdown for Undergraduate Statistics Education

Benjamin Motz, Indiana University, bmotz@indiana.edu

Abstract: This paper describes a course in introductory statistics and data analysis techniques taught thru the lens of fantasy football. The game's appeal and its natural applicability to empirical analysis sparked strong interest in topics that would otherwise be abstract and are traditionally unattractive; and evidence suggests that the course was a success. Furthermore, there was no correlation between fantasy experience and course achievement, indicating that fantasy football is an accessible avenue toward statistical concept learning. However, issues of the authenticity of learning activities to fantasy football gameplay seemed to arise, and may have dampened initial enthusiasm among students who were already experienced fantasy football managers. Nevertheless, in total, fantasy football is concluded to be an engaging, active, and immersive classroom application of statistical analysis, and a powerful tool toward statistics education reform.

3rd and Long for Statistics Education, Hand-Off to Fantasy Football

Introductory statistics is historically among the most reviled undergraduate courses (Connors et al., 1998; Schultz et al., 1998), commonly taught as mathematical theory, profuse with strange symbols, parametric jargon, and more beans in jars than real-world examples (Cobb & Moore, 1997). The last 20 years have been full with mounting efforts to reform statistics courses with increased emphasis on empirical thinking, relevant practical examples, exploratory data analysis, and active learning (Cobb, 1992; American Statistical Association, 2005). And while the field of statistics education slowly attempts to redefine itself, statistical literacy is among the most urgently desired skills in the modern workforce (McKinsey Global Institute, 2011; PCAST, 2012). There's both a strong need for statistics education to succeed, and it's got a long way to go.

Enter my mother-in-law, a self-proclaimed math-hater. A few years ago, needing one more manager, I invited her to join my fantasy football league. Her drafting strategy was comical (she took players that she "liked," not players who would perform well), and equally entertaining was her growing enthusiasm for fantasy football—including her novice attempts at smack-talk on the league message boards. But in that first season, what surprised me most was her growing appetite for (and appropriate use of) data. By Week 10, the math-hater was scrutinizing weekly running back projections like a seasoned Wall Street analyst might scrutinize an earnings report. She would compare forecasts with past performance, she considered the effects of modulating variables (should the defensive cornerback's stats affect my wide receiver choice?), and she ultimately made smart moves. There's something transformative about fantasy football, something that makes statistics not simply useful, but *attractive* (Halverson & Halverson, 2008). It was suddenly clear to me: I needed to develop a statistics course thru the lens of fantasy football. (1)

My course proposal received immediate support from university administrators, and was approved enthusiastically, on an accelerated schedule to ensure that it'd be listed in the subsequent year's course catalogue. There was a press release that made headlines in campus and regional newspapers, and this upcoming "fantasy football course" was featured on our NBC affiliate's evening newscast. Not a single lecture been given, but the consensus was clear: This course would be a wild success.

And the course ultimately was a success, but in retrospect, these remarkably high hopes that fantasy football would be the panacea of statistics education did not do justice to the complexities of integrating learning goals and fantasy football gameplay. In this paper, I will review my approach to the integration of fantasy football and statistical analysis, my successes and challenges, and conclude with summary insights gleaned from my experience using fantasy sports in education.

The Fantasy Football Phenomenon

Fantasy football (FF) is an extremely popular, multiplayer, strategic, online game. In the United States, it's estimated that over 30 million people participated in FF leagues last season (about 1 in 7 Americans; Fantasy Sports Trade Association, http://www.fsta.org). That's more than the number of Americans who visited museums last year (Americans for the Arts, 2012), and three times the number of World of Warcraft players (Olivetti, 2011)!

The standard FF game involves a league of 10 or 12 players, called “managers.” Near the start of the National Football League (NFL) season (which coincides conveniently with the start of a Fall semester), these managers participate in an online draft, systematically populating their fantasy football teams, selecting 15 real NFL players who are expected to perform well during real games of the NFL season. Managers will receive points for these players’ performances in weekly football games; for instance, 1 point is awarded for every 10 rushing yards gained, 6 points for a rushing touchdown, etc.

But while each manager has 15 players on his/her roster, there are only 9 “starting” positions— that is, only a subset of each manager’s roster can accumulate points. For each week of the season, the manager must determine which players to “start” (who will earn points) and which players to “bench” (who will remain on the team, but cannot contribute to that week’s point total). Managers can also adjust their rosters, either by trading players with other managers, or by replacing their players with undrafted players. During the season, managers go head-to-head in weekly matchups to see whose fantasy team earns the most points, and the manager with the most “wins” in these weekly matchups is crowned league champion. In this way, FF is a game of predictions and probabilities: Which NFL players will earn the most points each week?

No Punt Intended

STARTERS

POS	Player	Opp	Status	Stats	Fantasy Points
QB	M. Stafford QB - DET	IND	Loss, 33-35	313 Pass Yds, 2 Pass TD, 1 Int	18.52
RB	R. Rice RB - BAL	PIT	Loss, 20-23	78 Rush Yds, 1 Rush TD, 5 Rec Yds	14.30
RB	C. Spiller RB - BUF	JAC	Win, 34-18	77 Rush Yds, 1 Rush TD, 7 Rec Yds	14.40
WR	D. Bryant WR - DAL	PHI	Win, 38-33	98 Rec Yds, 2 Rec TD	21.80
WR	D. Moore WR - OAK	CLE	Loss, 17-20	31 Rec Yds	3.10
TE	J. Gresham TE - CIN	@SD	Win, 20-13	35 Rec Yds, 1 Rec TD, 1 Fum	7.50
W/R	B. Brown RB - PHI	@DAL	Loss, 33-38	169 Rush Yds, 2 Rush TD, 1 Fum, 14 Rec Yds	28.30
K	M. Bryant K - ATL	NO	Win, 23-13	2 PAT, 1 20-29, 1 40-49, 1 50+	13.00
DEF	Texans DEF	@TEN	Win, 24-10	10 Pts, 6 Sck, 3 Int, 3 Fum	22.00
				Total Points:	**142.92**

BENCH

POS	Player	Opp	Status	Stats	Fantasy Points
BN	C. Palmer QB - OAK	CLE	Loss, 17-20	351 Pass Yds, 2 Pass TD, 1 Int, 3 Rush Yds	20.34
BN	F. Jones RB - DAL	PHI	Win, 38-33	26 Rush Yds	2.60
BN	R. Bush RB - MIA	NE	Loss, 16-23	64 Rush Yds	6.40
BN	M. Wallace WR - PIT	@BAL	Win, 23-20	44 Rec Yds	4.40
BN	T. Smith WR - BAL	PIT	Loss, 20-23	33 Rec Yds	3.30
BN	A. Dalton QB - CIN	@SD	Win, 20-13	211 Pass Yds, 1 Pass TD, 2 Int, 5 Rush Yds, ...	14.94
				Bench Points:	51.98

Da Helmets

STARTERS

POS	Player	Opp	Status	Stats	Fantasy Points
QB	M. Ryan QB - ATL	NO	Win, 23-13	165 Pass Yds, 1 Pass TD, -2 Rush Yds	10.40
RB	D. Martin RB - TB	@DEN	Loss, 23-31	56 Rush Yds, 42 Rec Yds	9.80
RB	A. Morris RB - WAS	NYG	Win, 17-16	124 Rush Yds, 1 Fum	10.40
WR	R. Wayne WR - IND	@DET	Win, 35-33	51 Rec Yds	5.10
WR	A. Green WR - CIN	@SD	Win, 20-13	85 Rec Yds	8.50
TE	K. Rudolph TE - MIN	@GB	Loss, 14-23	51 Rec Yds, 1 Rec TD	11.10
W/R	R. Cobb WR - GB	MIN	Win, 23-14	62 Rec Yds, 5 Rush Yds	6.70
K	J. Tucker K - BAL	PIT	Loss, 20-23	2 PAT, 1 20-29, 1 40-49	8.00
DEF	Broncos DEF	TB	Win, 31-23	23 Pts, 1 Sck, 1 Int, 1 TD	9.00
				Total Points:	**79.00**

BENCH

POS	Player	Opp	Status	Stats	Fantasy Points
BN	A. Boldin WR - BAL	PIT	Loss, 20-23	81 Rec Yds, 1 Rec TD	14.10
BN	M. Forte RB - CHI	SEA	Loss, 17-23	66 Rush Yds, 30 Rec Yds, 1 Rec TD	15.60
BN	M. Bush RB - CHI	SEA	Loss, 17-23	39 Rush Yds	3.90
BN	R. Gronkowski TE - NE	@MIA	Win, 23-16		0.00
BN	L. McCoy RB - PHI	@DAL	Loss, 33-38		0.00
BN	Falcons DEF	NO	Win, 23-13	13 Pts, 1 Sck, 5 Int	15.00
				Bench Points:	48.60

Figure 1: Screenshot of a fantasy football matchup during week 13 of the 2012 NFL season, using NFL.com’s platform. Reproduced with permission. © 2012 NFL Enterprises LLC.

The Course: Prediction, Probability, and Pigskin

Being a game of predictions and probabilities, FF naturally lends itself to statistical analyses of player performance. An FF manager will routinely devour troves of sports stats (Comeau, 2007), attempting to glean some critical insight about a particular player’s odds of a high-scoring week. But how can this appetite for insight become rendered into generalizable, meaningful statistical concept learning in a college course?

Students should, at minimum, play the game. At the start of the semester, students took a short survey about their past experience with FF, and were arranged into 10-team leagues with matched levels of experience (so that fantasy newbies would not be intimated by veterans). At the end of the semester, the top 3 managers in each of these leagues would be rewarded with extra credit in the course.

Additionally, a large database of NFL statistics was compiled, aggregating 6-years' worth of weekly fantasy data from public sports websites. Workstations in computer labs around campus were configured to access this networked data source using Microsoft Excel.

The first half of the course was filled with practical exercises in data analysis using Microsoft Excel, exploring football statistics and using data to make informed predictions. In lectures and in weekly computer lab sections, students actively studied the football database. They calculated quarterback passer ratings and identified the best quarterbacks (while critically evaluating the passer rating equation), they quantified the home-field advantage for different player positions, they investigated differences in performance during rivalry and non-rivalry matchups, and more. All these exercises were intended to train students to employ basic methods for manipulating and analyzing datasets, such as sorting, filtering, summarizing, comparing, and quantifying variance. But rather than learning these methods in abstraction, students were drawn to these skills via active participation in FF problem solving, becoming socialized in the practical value of data analysis to urgent questions in the game system (Squire, 2006).

The second half of the course built on these new analytical skills, and introduced students to more advanced methods of data analysis, each presented as a practical tool for a specific analytical problem in the FF game system. We explored correlation, linear modeling, cluster analysis, factor analysis, and Monte Carlo simulation, each from an applied perspective—students were not taught mathematical foundations of these techniques. We also explored more "meta" issues in data analysis, such as human decision making processes and our propensity to make irrational choices in the face of uncertainty. Declarative knowledge about course topics was assessed in multiple-choice midterm and final exams.

But despite the course's focus on analytical methods, a critical learning goal was for students to be more than just data-jockeys—successful students should be able to translate patterns observed into meaningful, actionable insights. These insights informed the wheeling and dealing efforts involved in FF (e.g., "…and for these reasons, I should activate Cam Newton over Aaron Rogers"), which are issues of great interest (and contention) to managers. Past work had shown that open discourse about gameplay has the ability to facilitate and incentivize empirical reasoning and critical approaches (Steinkuehler & Duncan, 2008). Thus, a substantial portion of the students' grades was determined by their ability to generalize the analyses explored in class, to craft and communicate original insights. A public Wordpress blogging environment was developed (http://pigskin.psych.indiana.edu), and students were required to submit weekly posts and commentary, acting as fantasy football pundits rendering expert predictions and FF advice.

Interest and Achievement

Early in the semester, a reporter for my university's communications office came to interview some of the students. The following quote appeared in the subsequent article:

> "I expected it to be more technical, but it's fun," said Sarah M., a junior from Palm Springs, Calif., who is studying studio art… "It's not the normal sitting in a class falling asleep. It's interesting." (quoted by James, 2012)

Ignoring any symptoms of narcolepsy, Sarah's sentiment about the course was corroborated in end of semester student evaluations: Students' interest in subject matter ranked in the 88th percentile of all university courses. Without question, the crowning success of the course was that I was teaching analytical and statistical concepts (sometimes *hard* statistical concepts), and yet, students were interested. And while "interest" may seem a trite or obvious goal, inspiring student interest pays pedagogical dividends. Research has shown that individuals who are interested will retain significantly more from brief exposure to the material than individuals who are saturated by the same material, but who find the content uninteresting (Hambrick et al., 2008). Moreover, students are much more likely to attend to deep themes, synthesizing and remembering core information, simply when motivated to find interest in the content (McDaniel et al., 2000).

These positive learning outcomes were not limited to those students who entered the course with FF expertise. The number of years students had previously played FF (reported on a survey at the start of the semester) were uncorrelated with end of semester course grades, $r = -.012$, *ns*. Students with absolutely no FF experience found the game, and the course, to be accessible and engaging. Moreover, despite some speculative claims that FF statistical savvy is an expressly masculine activity (Davis & Duncan, 2006), male and female students' course grades were at parity, $t(57) = .709$, *ns*, and anecdotally, some of the most enthusiastic players and engaged students were females that had not previously played FF. We had spectacular in-class discussions about FF strategy and applications of analytical tools, and I was constantly impressed by the enthusiasm of FF newbies.

While I assert that student performance was generally impressive and high quality, I don't have a valid basis for quantitative comparison. The average cumulative percent score in the course was 83% (excluding extra credit for FF standings), which is relatively high for introductory statistics. Scores on blogging activities were highly correlated with scores on midterm and final exams, $r = .656$, $p < .001$, and neither blog scores (worth 40% of grade) nor exam scores (worth 30% of grade) were significantly more predictive of cumulative final class standing, $F(1, 57) = .015$, *ns*, suggestive that students were learning generalizable skills and transferrable concepts using FF. A handful of students proudly reported that they were spontaneously applying course concepts beyond the required classwork, digging deeper into the football data to satisfy curiosities, and compiling datasets and running analyses for other extra-curricular interests. But not all students were so impressive, and course grades took the form of the canonical bell-shaped curve; some students produced work that was phenomenal, while some others were mediocre, as readers might observe on the blogging platform.

Experience and Engagement

A course about FF is, as one might expect, exceptionally attractive to experienced FF players. In that way, some students may have signed-up with a mindset that mismatched the course's learning objectives: enrolling because of strong interest in FF, not because of any interest in applying statistical analyses to FF. While these are not mutually exclusive, it was apparent that some students found the coursework to be unauthentic distortions of their original reasons for enrolling, and some of the most vocal class participants during discussions of FF, sage FF veterans, would noticeably "tune out" when the discussion turned more squarely toward analytical methods. There is some empirical support for the theory that experienced FF players, in particular, became less engaged: students were asked in the beginning of the semester how much time they *planned* to invest in the course, and at the end of the semester, how much time they had *previously* invested in the course. By the end of the semester, students with more FF experience had invested significantly less time in their coursework than originally planned, and there was no such difference between planned/actual time investments for FF novices, $F(1, 51) = 10.773$, $p = .002$ (see Figure 2).

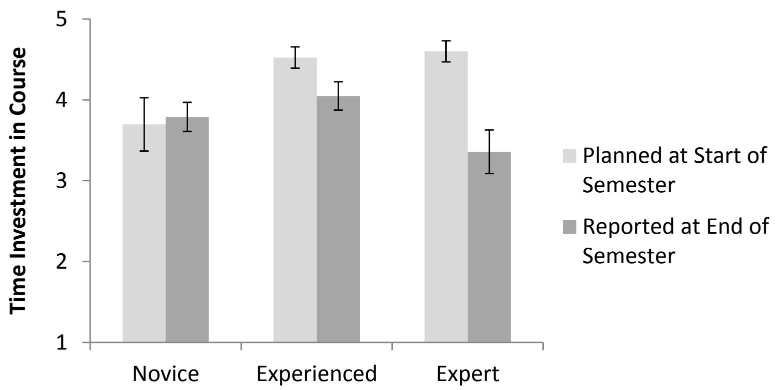

Figure 2: Students' planned time investment in course at start of semester, and reported time investment at the end of the semester. "Novice" indicates students who had no experience in fantasy football prior to the course (19 students), "Experienced" had 1-4 years (21 students), and "Expert" had 5 or more years of experience (14 students). Larger numbers indicate increased self-reported time investment on a 5-point scale. Error bars indicate +/- one standard error.

This issue of a perceived mismatch between "games for fun" and "games for learning" has been previously observed (Steinkuehler et al., 2011), and current results suggest this may be particularly pronounced for students with extensive gameplay experience. These results cannot be explained by the experts feeling unchallenged by an uncompetitive classroom gameplay environment, since student leagues were organized to match FF experience levels; even the seats in lecture and laboratory were assigned specifically to group experts with one another. The experts were very much involved in their leagues, there was no shortage of competitiveness; engagement hurdles are unlikely due to lessened competition in these classroom leagues. Fortunately for their GPAs, years of FF experience were not correlated with course performance, and these experts were at no disadvantage. However, students with more fantasy football experience reported significantly less learned proficiency in data analysis as a result of their coursework, $r = -.288$, $p = .037$. This negative correlation between FF experience and self-reported learning outcomes may result from FF experts entering the course with data analysis proficiency *a priori*, as previous FF gameplay would have implicitly incentivized data consumption. But whether due to perceived incongruities between learning and gameplay, or due to extant familiarity with data analysis, there was a measurable engagement hurdle with students who were experienced FF managers.

Another symptom of this mismatch between "games for fun" and "games for learning" became apparent earlier in the semester. I had originally provided weekly analytical puzzles, short explorations of the football database which, if answered correctly, would yield 5 "bonus points" toward the student's FF matchup that week (e.g., "What is the correlation coefficient that describes the relationship between fantasy points for a team's starting quarterback and place kicker?"). Despite the attractiveness of these bonus points, and repeated reminders in class and via email, only 10% of the students would complete these puzzles. When asked outright, "Why aren't more of you completing the puzzle?" a strange consensus emerged among the students: "If I won/lost my matchup because of those bonus points, that'd be cheating." There was something fundamentally illegitimate about changing the rules of the game to incentivize coursework, and as one might expect, these claims of illegitimacy came primarily from students who were experienced FF managers.

Case Summary

Fantasy Football was observed sparking interest and achievement in introductory statistics, and leading to broad learning outcomes including new declarative knowledge about statistics (measured by multiple choice exams) as well as improved analytical reasoning skills (measured by blog posts). It provided an engaging and immersive example application of otherwise abstract material, creating a learning experience whereby analytical techniques were made relevant, accessible, and useful—exactly the type of approach advocated by statistics education reform. And anecdotally, I was thoroughly impressed by the new skills (both reasoning ability and technical proficiency) demonstrated by the students.

However, the authenticity of learning activities to FF gameplay is an issue that may disproportionately inhibit students who are more experienced in FF. Future efforts might be made to advertise the course to FF novices specifically, as FF experts may already demonstrate reasonable aptitude with some data analysis techniques and/or may be less inclined to "colonize" their gaming activities with coursework. However, armed with the knowledge that more FF experience may obstruct engagement, an effective instructional strategy might be to focus increased attention on the veterans, rather than allow them to become sidelined. Experts might be engaged by asking them to recount anecdotes about FF scenarios that might lead necessarily toward analytical solutions, having them provide informal constructive tutelage to novices on FF strategy, or otherwise make them feel like their expertise plays an important role in the class discourse beyond the issues of gameplay.

Why do people play fantasy football? Factor analysis suggests that most FF engagement is mediated by competitiveness and social identification (Curry, 2009; Lewis, 2012; see also Haverson & Haverson, 2008), and a successful learning application of FF will not marginalize these. Efforts should be made to incentivize competitiveness in a student league (in this case, by offering extra credit for FF success), with classmates who are at similar skill levels, and class time should be dedicated to open discussion of FF news and league outcomes to facilitate interpersonal connections. Oftentimes these discussions would lead logically toward issues that are conducive to empirical analysis ("Could anyone have predicted that Anquan Boldin would do better than Reggie Wayne?"), which is exactly the "hook" that makes FF such an effective educational activity in statistics.

Endnotes

(1) Others have previously used fantasy football to achieve similar learning objectives. John Hagen's remedial algebra class at Foothill High School (featured at http://sports.espn.go.com/espn/news/story?id=2680335), Dan Flockhart's (2007) middle school textbook, and a popular New York Times blog post (Honner & Ojalvo, 2011) are noteworthy examples. Additionally, Blake Scott recently conducted a course on fantasy football rhetoric at the University of Central Florida.

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The Pythagorean Temple: Creating a Game-Like Summative Assessment

John Murphy, Grant Tumen, ChicagoQuest Schools
jmurphy@chicagoquest.org, gtumen@chicagoquest.org

Abstract: ChicagoQuest is a middle school where teachers, game designers, and curriculum designers collaborate to create a game-like curriculum that is relevant and engaging while teaching 21st-century skills. As part of the curriculum for our integrated math and English class, eighth grade students attempted to uncover the secrets of an ancient secret society called the Pythagorean Brotherhood, based on a historically real secret society. We decided to make an iPad game that related to the narrative of revealing the secrets of the Pythagorean Brotherhood that we could use as the final assessment of students' understanding of linear equations and the Pythagorean theorem for the trimester-long mission. In this postmortem of The Pythagorean Temple, we detail our design process, outcomes and next steps that came out of our first attempt at applying game-like learning and our curriculum design model to a digital game-like end-of-trimester performance task.

Introduction

At ChicagoQuest, teachers, game designers, and curriculum designers collaborate to create a game-like curriculum that is relevant and engaging while teaching 21st-century skills. The school is currently a 6-8 middle school with plans to add a grade each year through 12th grade. We employ a unique standards-based integrated curriculum that mimics the action and design principles of games by generating a compelling "need to know" in the classroom. Each trimester, students encounter a series of increasingly complex narrative challenges, games or quests, where learning, knowledge sharing, feedback, reflection and next steps emerge as a natural function of play. Our curriculum design model is based on that developed by the Institute of Play in conjunction with our sister school, Quest to Learn.

As part of Codeworlds, our integrated math and English class, we challenged eighth grade students to uncover the secrets of an ancient secret society called the Pythagorean Brotherhood, based on a historically real secret society. Students took on the role of archeological explorers who needed to uncover the secrets left by the Pythagorean Brotherhood by using math to decipher codes, discover patterns and follow clues. The narrative of the trimester-long "mission" was modeled after mystery-solving adventures such as those in Indiana Jones films and the Uncharted videogame series. Using this narrative as a backdrop, students used linear equations and the Pythagorean theorem in order to solve puzzles and uncover clues that led them to various locations in order to unlock the secret society's...secrets.

Developing the Game

The idea to develop a game to help assess students' understanding of linear equations and the Pythagorean theorem came out of our curriculum meetings in our in-house design studio, Mission Lab, where the game designers and curriculum specialists work with teachers to develop the curriculum. One of the main responsibilities of the curriculum specialists and game designers is to meet with each teacher (or pair of teachers) at every grade level and domain. The collaborative, organic design partnership between teacher, curriculum specialist, and game designer is at the core of the curriculum design model. As game designers, our role is to find ways to take the learning goals and standards and make learning more relevant, compelling, and fun for the students, in addition to shaping the overall game-like narrative of the classroom experience.

The Mission Lab team has a goal to make at least one digital game per trimester. We were halfway through the first trimester, and at that point in the school year we had primarily designed analog games for the classroom while making use of pre-existing digital games. We were looking for a promising candidate for our next digital game, and we were interested in using a game for assessment of what had been learned, rather than as a means of teaching or reinforcing. We also wanted to leverage the students' affinity for their classroom set of iPads. So, we decided to make an iPad game that related to the narrative of revealing the secrets of the Pythagorean Brotherhood that we could use as the final assessment for the trimester-long mission.

We decided to make an iPad game in which the player had to use their understanding of linear equations and the Pythagorean theorem in order to make their way through an ancient temple where the Pythagorean Brotherhood had hidden their most important secrets. We felt that it was a compelling narrative hook to have students in the role of archeological explorers uncovering a conspiracy. Also, given that there was actually a secret society formed around Pythagoras's teachings, we felt that we couldn't pass up the opportunity embed the Pythagorean theorem unit in a secret society narrative. The teacher was also excited about the Pythagorean Brotherhood mission concept. We feel that that is important because the teacher needs to be excited about the mission narrative in order to "sell" the narrative to the students. We felt that it was a natural fit for the assessment of the students' learning over the course of the trimester to be tied to the culminating event in the narrative.

Once we had decided that the iPad game assessment would be the students' final performance task for the mission, we wanted to figure out how to tie it to the mission narrative. We decided that the game would take place in the hidden temple where the Pythagorean brotherhood kept their most well-guarded secrets. Players would need to get past a series of obstacles in order to make their way into the depths of the temple. Our next step was to determine which skills we wanted students to use to play through the game. We worked with the teacher and curriculum specialist to determine which standards and skills they wanted the students to understand by the end of the trimester and determined which would benefit most from inclusion in the game. We decided that, due to time constraints, we would only incorporate linear equation-related skills for this iteration of the game. Because the Pythagorean theorem content came later in both the trimester and in the planned progression of the game, we decided to wait to incorporate that part of the game and assessment until the following year's iteration. We then diagrammed, discussed and created four digital prototypes that required the following skills: graphing linear equations, completing linear equation tables, converting between different forms of linear equations, and completing slope-intercept form linear equations. For each skill, we prototyped a mechanic that was well-adapted to both the skill and to the iPad interface. We looked at popular iOS games and other games to help inform our approach to making a usable and fun interface for the game. For linear equation graphing, we used a touch-and-release mechanic to position two points to define a line (see Figure 1). Another example is our use of an iOS-style rotary-swiping mechanic to fill in coefficients in the slope-intercept equation completion prototype (see Figure 2).

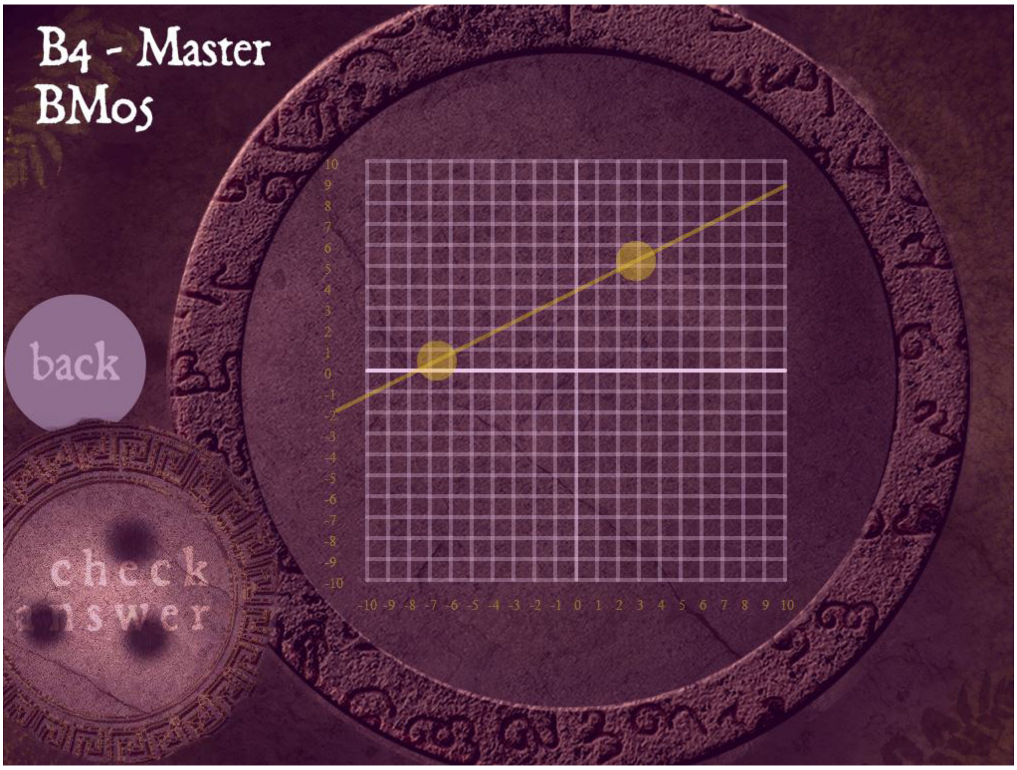

Figure 1: Defining a line by plotting points in The Pythagorean Temple.

Our next step was to find a way to sew together these different minigames to form a cohesive experience. We had noticed that students were really interested in 'infinite running' iOS games like Temple Run, so we wanted to try to incorporate a similarly action-oriented mechanic in our game. However, we knew that we didn't have time to make both a satisfying running mechanic and develop the math minigames. We decided to make a slower-paced game where players needed to move through a multi-floor maze of rooms in order to find their way to the door to the next floor of the temple. Each room would have several doors leading to adjacent rooms. The doors were to be locked, and players needed to complete challenges to unlock the doors. For example, to open one kind of door the students needed to place two points, by touching and dragging them on the iPad screen, on the coordinate plane in order to graph a specific linear equation. The goal was to give players choice as to the path they could take through a level in order to get to the exit, as well as choice in how many of the different types of challenges they completed. For example, a player could avoid some of the linear graphing doors by going through more rooms (and completing more challenges?), but any path through a floor of the temple required a player to complete some of each kind of challenge.

Figure 2: Completing slope-intercept linear equations with the iOS swipe mechanic.

We realized that this design required us to make a large space that would not be used by most players. A large maze with many possible paths means that most players won't explore most areas of the map, leading to extra work in terms of level design and mathematical challenge design. Creating many paths would allow for player choice, but it would not necessarily be very meaningful choice. We knew that we could create meaningful choice by placing power-ups, treasure, etc. around the map, but we also knew that we didn't have time to include such things in this first iteration of the game. This led to a hub-and-spoke redesign, where players had to unlock "wings" of each floor in order to access three different chambers. Each chamber had a set of challenges, and each challenge opened a small door that let in a shaft of light that bounced off of mirrors and into the central hub of the level (see Figure 3). If enough light was reflected onto an object in the central hub, a door in the floor opened and the player moved into the next floor down. This design eliminated much of the additional spaces and challenges we would have needed to create while retaining the choice in how the player progresses through the game.

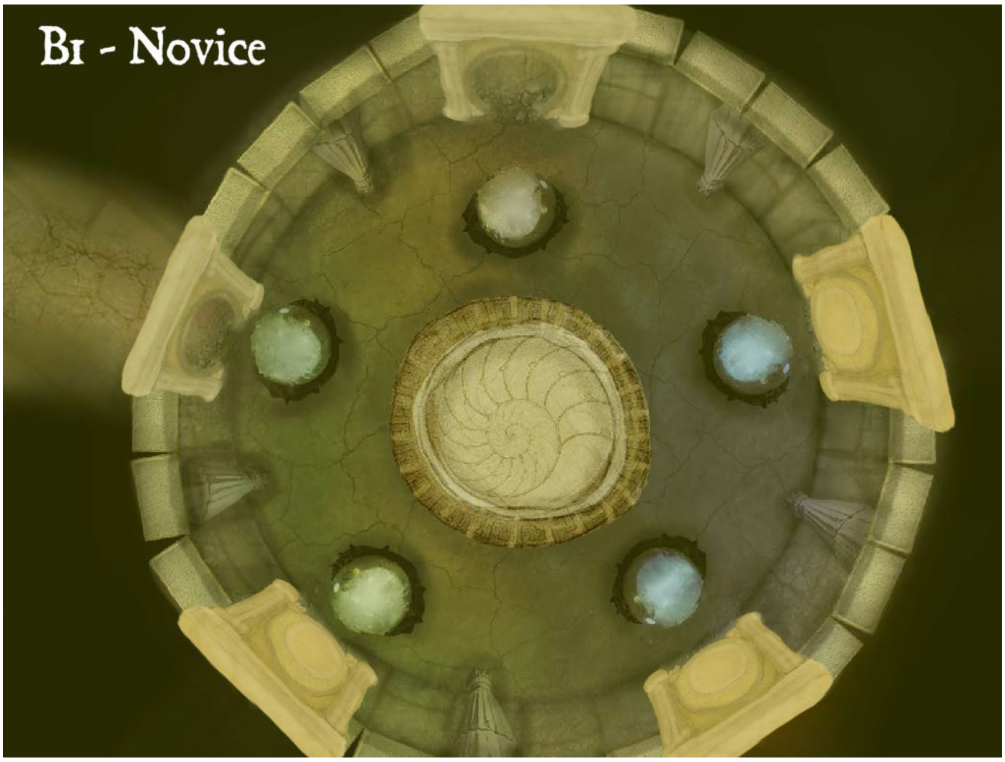

Figure 3: The central chamber of one of the floors of The Pythagorean Temple.

At this point, we began putting all of the pieces together. We built out the functionality of the individual light-door challenges. We built the “overworld” from which the light-door challenges could be accessed, and which showed the progress toward unleashing enough light to progress to the next floor. We produced art to create the appropriate ancient temple feel. We wrote code to pull in and parse the necessary input data and correct answers. This allowed us to turn a text file into a set of challenges that is imported into the application to fill in all of the challenges in the game. We worked with the curriculum specialist to determine how to scale the difficulty of these different challenges so that each of four floors of the temple could have its own difficulty level, with difficulty increasing as the player makes his or her way deeper into the temple. Once this was done, we were able to create a final challenge file that the app could interpret. We designed a “codex”, a hard-copy document with the appearance of an ancient tome. The codex included the prompts or clues for the challenges, so that when the player approached a door in-game, he or she could look at the symbols above the door and find that set of symbols in their codex. Each set of symbols in the codex was associated with a hint or problem the player used as a key to open the door (see Figure 4).

The Game in the Classroom

The execution of the game in the classroom was relatively straightforward. Students were told ahead of time that the game was to be their final task, and that they had to use their codex to find their way to the secret hidden deep beneath the temple. They knew some time in advance that their final assessment was going to be a game, and that it was going to be fun, challenging *and* part of their grade for the class. The initial plan was to have each student have their own codex and iPad, and to work individually to get as deep into the temple as they could, given the linear equation knowledge and skills they had acquired leading up to this point in the trimester. Due to technical difficulties in deploying the game to the iPads, we had fewer iPads than students. The teacher suggested that we have students work in pairs.

The student reaction to the game was interesting. Taking advantage of the core mechanics of the iOS interface resulted in students being able to pick up and play without a second thought. Because they had their codices next to them, they understood that they could use them to unlock doors as soon as they came to the first coded door. The students approached the game with the same willingness and focus with which they had approached other games where their performance was not assessed.

The students didn't have trouble interfacing with the game, but they did have trouble with the math. It turned out that many of the students didn't have a firm grasp on the content that their class had covered leading up to that point in the trimester. The most interesting thing about this scenario was that, unlike with a standard pencil-and-paper assessment, the students had an immediate "need to know" the content that they had failed to learn over the course of the trimester. They demanded to have the content taught to them in the moment. We had to find a balance between giving the students hints and letting the performance task serve its assessment purpose. We did this by directing them to their notes from the trimester, encouraging them to make use of a resource that they had created that they could use to help them with the task at hand.

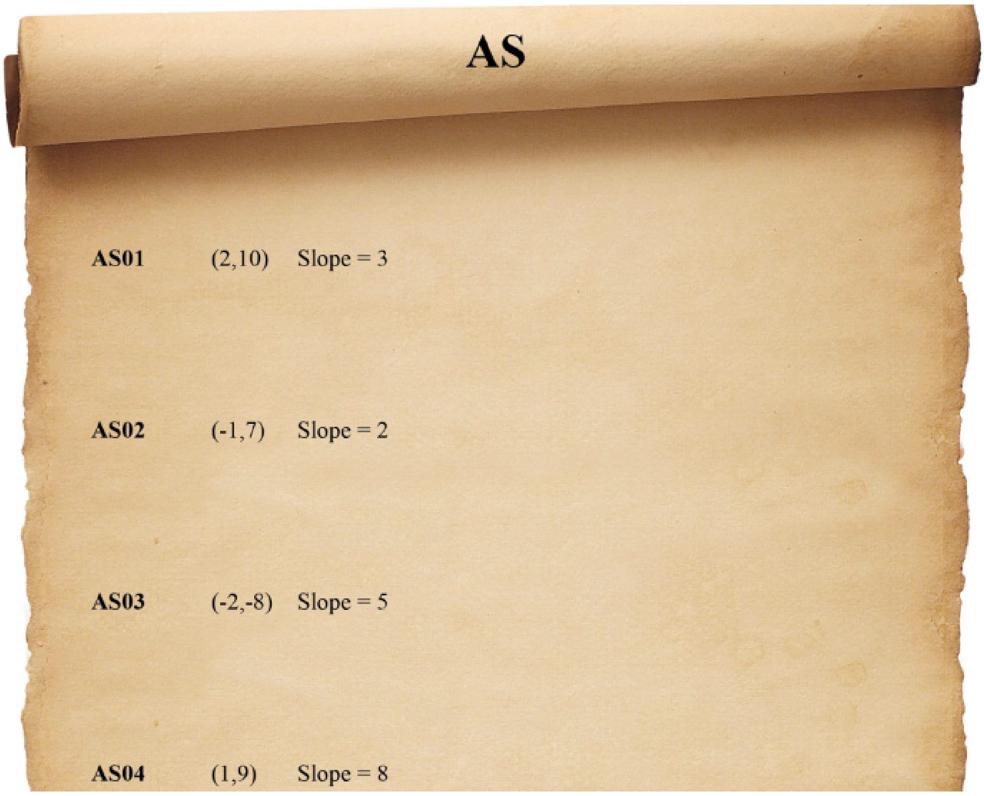

Figure 4: A page from the paper codex used to open the doors of the temple.

The teacher assessed each student by observing how deep into the temple they were able to travel in the allotted time. While developing the game, we worked with the curriculum specialist in order to create four different tiers of difficulty for each of the four mathematical challenges. The temple consisted for four floors, starting at ground level and going deeper underground. Each floor contained all types of challenges, but at a different difficulty level. The measure of performance used was simply which floor a pair of students reached.

Lessons Learned and Next Steps

We learned several lessons from this first attempt at making a digital performance task. When it came to content, students were not as prepared for the assessment as one would have liked, but we learned that having a performance task presented to students in the form of a digital game resulted in the students displaying more tenacity when unsure how to complete a challenge. Students also very actively asked for just-in-time explanations of the content tested by the game. This seemed to be because the students wanted to beat the game, rather than out of a desire to do well on the assessment. Several students, having made it very close to the end of the game, had to be verbally shooed out of the room to their next class because they couldn't pull themselves away. We came away wanting to find more opportunities to create that experience and attitude earlier in the trimester. Students also seemed to benefit greatly from working in pairs, which we discovered accidentally as a result of technical problems.

This first attempt at making a digital game performance task has us excited about next steps and improvements that we can make to the game. First, we want to change the way we introduce the game. Our current plan is to present the game to the students when they are completely incapable of completing it in order to create a strong need to know. Then we will present smaller chunks of gameplay to the students throughout the trimester. For example, as part of the lesson for each topic we could present students with a smaller temple that contains part of a key that needs to be assembled before they can gain access to the final challenge. This way we can harness the students' tendency to ask for just-in-time explanations of the content well before the "boss."

There are many improvements that we could make to the game in order to increase its usability for teachers and students. We need to make it easier for teachers to create on their own problem sets by finding a more user-friendly method of creating the text document that holds the problem set data. If we made it easier for the teacher to create new problem sets, it would allow us to get more out of the game without much additional time spent by Mission Lab. In addition to allowing Mission Lab to move on to other projects, when teachers are comfortable working with the games and materials we develop for them, it allows them to more effectively incorporate the games into their lessons. The trimester-long mission, of which this game was a part, covered linear equations and the Pythagorean theorem, but the game doesn't yet include any challenges related to the Pythagorean theorem, so we would like to expand the kinds of challenges included in the game. In the next iteration, we plan to go through the same process of isolating the skills we would like students to demonstrate, creating game mechanics that align with and test those skills, and building prototypes of those minigames before incorporating them into the game. We would also like to add a layer of polish to the game in the form of sound, characters, and visual player feedback to make the game even more compelling.

The ability to use this game for assessment needs to be expanded. Currently, the floor that a student reaches in the four-floor temple is used as the measure of their learning. We want to capture and make use of the data that players are producing, such as how many times they fail on a challenge and which types of challenges students find most difficult. We could do a lot with this data. As game designers, we can improve the design of this game and future games by looking at where players get stuck or confused. We could do this by creating a database that records player actions for later reference. Teachers could make more granular assessments of student understanding by observing which kinds of problems are most challenging for any given student. We could do this by creating a companion application that the teacher could use to keep track of student performance on the fly.

We feel that this game makes clear the potential to make teaching and assessment easier and more compelling for students and teachers through game-like learning. Students were engaged and hungry for information. The teacher was able to easily spot and support students who wanted to understand and succeed. Creating a game specifically for assessment resulted in something that we feel can be used to engage students and gauge their understanding throughout the learning process. We hope to apply some of these lessons to future iterations of this game as well as future projects.

Exploring Gamification Techniques for Classroom Management

Scott Nicholson, Syracuse University School of Information Studies,
245 Hinds Hall, Syracuse, NY 13244, scott@scottnicholson.com

Abstract: A variety of gamification techniques from the literature are used in two college courses. Some techniques, such as an experience point-based system and leaderboards, proved confusing or frustrating, while other techniques, such as adding a meaningful narrative layer and allowing students to create their own learning paths, engaged students more deeply. In this article, the techniques used and the effects of each are explored and suggestions are provided for instructors considering adding game layers to the classroom.

Introduction

Over the last few years, several guides to using gamification for classroom management have been published. Best known is Lee Sheldon who presents many concepts from online roleplaying games in his book *The Mutliplayer Classroom: Designing Coursework as a Game* (2012). The app *Superfunner* was designed to help teachers give students experience points and badges for different classroom activities. At Deterding's workshop on gamification during the 2012 Games+Learning+Society 8.0 educators' symposium, workshop attendees shared a variety of techniques for gamification in the classroom, many of which centered on points, levels, leaderboards, badges, and achievements (Deterding, 2012). Kapp's book, *The Gamification of Learning and Instruction*, covers all of the above and expands the discussion to include concepts of serious games and facilitated learning experiences.

During the Fall 2012 semester, I incorporated many of these game-based techniques into two college courses. One of the courses, *Meaningful Gamification*, was online asynchronous and was open to both undergraduates and graduates. The other course, a campus-based course on public speaking and design, was a required course for undergraduate students. In each class, I introduced different game layers on top of classroom content, monitored the students as they engaged with the systems, and led the students through reflections about the value of each system. Some of the systems worked while others failed; some of the systems were changed mid-semester and others were adapted along the way. The results will guide those considering adding gamification for classroom management toward making more appropriate choices for their students.

Gamifying Gamification

The concept of meaningful gamification is that the primary use of game layers is not to provide external rewards, but rather to help participants find a deeper connection to the underyling topic. This is done through game elements that focus on concepts of play, that provide information and choice, and that encourage reflection (Nicholson, 2012). Without a good understanding of reward-based gamification, however, students would not fully understand how meaningful gamification is different. Therefore, the goals for the meaningful gamification course were to first teach students about reward-based gamification and then explore meaningful gamification.

The Plan

In order to ensure that students had a shared reward-based gamification experience, the course first focused on reward-based gamification techniques. Students created a character for the *Quest for Mount Gamification*, where their elevation (points) gained would take them up to higher levels and better grades. Students earned points for many different things in the class, such as posting on the discussion boards and bringing in outside articles. There were achievements to be earned and challenges issued with unknown rewards. A leaderboard using the students' character names tracked weekly progress. During the first six weeks of class, readings were selected that were supportive of reward-based gamification, and the lectures covered aspects of points, levels, leaderboards, badges, achievements, and operant conditioning.

After six weeks, the plan for the class was that students would be given a choice to continue with the course as it was going, or to get rid of the gamification layers and start from a blank slate. If the class voted to get rid of the existing layers, then the students would be put in groups and have a few weeks to create their own syllabus and gamification systems for the last month of class. The class would then vote on which syllabus they liked, and I would facilitate the gamification system the students created for themselves.

What Happened

At the beginning, students were engaged with the reward-based gamification system. Many of them wrote lengthy backstories about their characters in the first week. About half of them lept into the point-based system by working on many different types of class activities. A few students contacted me directly with concerns about this system, and I suggested that they just trust me and engage with what was happening.

After the novelty wore off, the initial energy faded for many of the students. At the core of this fading was the class leaderboards. A few students continued to keep a frenetic pace and were fighting to be on top of the leaderboard, while other students stopped engaging in the class altogether. These students later reflected that the leaderboards were a demotivating factor; once the gap grew between the leaders and the rest of the class, there was little reason to pursue more of these points. One student said "I did all right, but as weeks passed I began to slip more into the lower-middle part of the group…. my mind somehow dissociated the points from my grade. I didn't calculate how many points I needed, or what points equaled what grade; I just saw that I was doing good enough and left it at that. So, strangely enough, these game elements actually made me view this class as less of a class (and therefore as less of a priority). In this class, I had an okay position on the leaderboard and very little chance of upwards mobility. I guess my brain couldn't cope with that and sort of shut down about this class."

Figure 1 shows the cumulative points earned in the gamification system through class discussions; one can see by looking at the number of flat lines during weeks 4-6 that most students in the class had stopped working these points. While leaderboards helped the strongest students, they demotivated the other students in the class. This leads to an important lesson for those adding game elements to a classroom: game elements should help the weaker students in the class succeed.

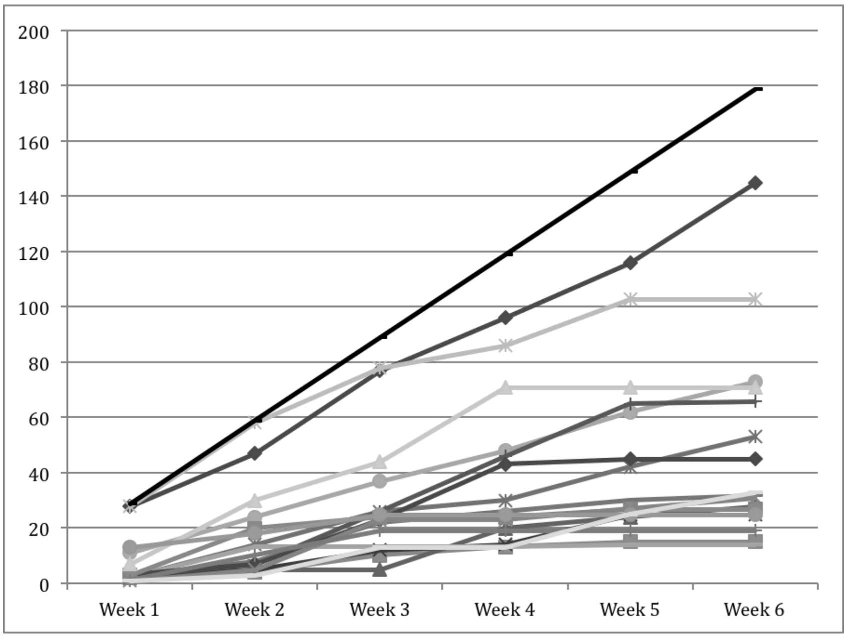

***Table 1*: Cumulative class participation scores of students**

After six weeks, the students received a video inspired from their mad wizard guide offering them a *Matrix*-style choice – to choose red and start a completely different adventure that they would help create, or to choose blue and everything would go on just the way it was. All of the class except for one person (the top performer on the leaderboard) voted to change the class. Several of the other top performers admitted that they felt it would be better for them to keep the class the way it was, but wanted to see what else might happen, so voted to change the class.

When the students logged into the class Monday morning, the old syllabus and scoring systems were gone, and students were greeted with the challenge to create a new syllabus, assignments, and gamification system that would run for the last month of class. The next week of class was spent debriefing the experience and letting students vent and discuss the old system. Over those next few weeks, the class focused on concepts of meaningful gamification in order to guide the students in how to create something that would engage them at a deeper level. The syllabi were presented to the class, and the class voted on each area of the syllabus. The class ended up liking different pieces from various syllabi, so I brought different pieces together into their syllabus for the remainder of the class.

One of the challenges was how to deal with the first six weeks of class. In our debriefing, I learned that many students were going to drop the class as they were so demoralized about being low on the leaderboards with no way up. One student reflected: “I had the opportunity to earn just as many points as everybody else, so it was my fault I was still at level 1, but that didn’t mean it wasn’t really discouraging. The more opportunities for earning points I missed, the more I felt disengaged and resentful, even if it was my choice to miss them.” Another student responded: “I had essentially the reverse behavioral reaction of hers. I’m a points hound. I have been for years. If I know there are points to be had, I crave them. It may be I want them for the sake of having earned them, but I do think I was conditioned as a child with continuous external rewards to earn points.” I also contacted the students who had dropped the class, and one of them felt that the gamification system was ridiculous and demeaning.

They were also frustrated about the mismatch between the narrative and the activities in the class; their characters served as nothing more than pseudonyms for the leaderboards. The students who had worked hard during the first six weeks wanted credit for their efforts, while the students who had fallen victim to bad gamification still wanted a chance to earn a good grade.

One group came up with an excellent solution: students would assess what they had done in the class, set their own goal grade, and then create a set of assignments (taken from a very long list generated by another group) that enabled them to reach their goal. I negotiated with each student to ensure that the workload was fair given what he or she had done during the first half of the class. Students were allowed to re-do these projects until the work was satisfactory. Some students wrote long papers while others created videos, games, or annotated presentations. In the end, every student except for one succeeded in all steps of their own plans.

The tone of the class changed through a new narrative proposed by one of the groups. The students became lab rats attempting to escape the maze put forth by a mad scientist; the entire *Quest for Mount Gamification* was just an experiment they were finished with. They were put into Rat Packs for support and course discussions, and could visit the Ratskeller to toast each other’s accomplishments with student-created achievements. To escape, each student would have to complete his or her personalized set of experiences, and then leap into the Big Dark Place with a paper, video, or presentation on the Future of Gamification in a setting of his or her choosing.

Much to their amusement, I embraced the role of the mad scientist, donning a lab coat and creating weekly videos from their vantage point in a looming maze as I talked to an offscreen nurse about their progress. We all engaged with the narrative and it enhanced the remainder of the class by providing a sense of light-heartedness that was needed after the emotionally difficult beginning. The resulting experience was customized to each student, created peer support groups, and encouraged students to attempt difficult challenges as it allowed for failure. As one student said, “I’m convinced I couldn’t have properly understood gamification and pointsification and lots of aspects of motivation unless we’d been experimented on this way. Not knowing we were being subjected to the structural elements we were learning about ahead of time made it more meaningful when it was revealed later. It gave me a personal connection with the content because I’d just lived it.”

This success is predicted by Deci & Ryan’s Self-Determination Theory (2004). In this theory, learners require three things – autonomy, competency, and relatedness. Participants perform better when they have control over what they are exploring; and in this class the students got to set their own paths of learning. Participants benefit when they feel they are gaining competence; likewise, the students got to re-do assignments until they reached a satisfactory level. Participants have a better mental state when they can connect to other people and the world around them; likewise, students were engaged with other students in small discussion groups and then applied gamification to a topic area of interest. This theory is at the base of meaningful gamification with the hopes of using game elements to help people engage more deeply with non-game settings.

Gamification for Non-Gamers

Another class that I taught was an undergraduate course on Information Reporting and Presentation. This required course drew students from several different departments. What made this course different from many of the courses that have used gamification techniques is that it is not a gaming course and many of the students did not self-identify as gamers.

For this course, I tried using several of the methods for gamification presented in Sheldon’s *The Mutliplayer Classroom* (2012). I started the students at 0 points (F) and let them improve that grade by earning points, and I gave them a variety of required and optional assignments and the ability to re-do assignments to earn those points. I also had an “achievement” system that provided surprise kudos for good contributions. There was an overarching narrative to the class. Finally, I used a variable ratio reward structure for in-class activities, where students did not know when points would be rewarded, as this is purported to be the most effect reward structure for bringing about a behavior (Zichermann & Cunningham, 2011).

During this semester, some of these aspects worked well and other aspects worked poorly. In order to get an idea of what the students felt about these different aspects of the course, I did a survey where I asked questions about each aspect. I also had an assignment where students were put into groups and asked to re-develop the syllabus for this course. This gave me two different perspectives from the students about these gamification elements.

Using a Story for Engagement

One of the successful aspects of the class was using a narrative layer over the course that gave the students control. As students walked in on the first day, I greeted them as The Boss, and invited them, one-by-one, to come up to the front of the class to select a topic from a basket and videotape their one-minute introduction and discussion of the topic. After all of the videos were done, I handed out the syllabus, the front page of which was a memo welcoming each student as the new Head of External Communication for “the company”.

After this, I then introduced myself and ran the more typical first-day class, but dropping the students into the narrative from the beginning helped them get involved. Students were then able to pick what real-life company they were working for, and all semester the assignments were communication activities related to the company. The final project had the students being hired as adjuncts to teach this class, so they had to create a their own syllabus.

Students got engaged in the assignments as they were able to take on the role of working for Microsoft, the NBA, or Disney. It created a professional-level standard for assignments that took students beyond the “earning an A” concept; I could remind students that they were representing their company in their communications. As the semester went on, some students really got into their roles as representing companies; one student brought a case of Coca-Cola to go along with a presentation, for example.

Using Rewards to Increase Participation

Two of the aspects of the class that worked to increase participation were the achievements and the in-class activities. When students contributed in class in a meaningful way, I thanked them for their contribution and handed them a small plastic ring and advised them to bring it with them to class. I didn’t explain anything further, so the mystery of the rings intrigued some of the students. Later in the class, those students with rings were the leaders for a group project, so the achievements allowed me to track students who might be appropriate for these leadership roles.

The in-class activities also worked to bring students to class. This technique is one that instructors have used for years with pop quizzes and other unannounced assessments. Some of these activities were more mundane, such as quizzes, while others were more playful, such as improvisational games that rewarded students for participating. This concept was presented on the first day of class, as students were rewarded for creating their first-day video. While I had hoped that students would choose to be engaged with class and do suggested readings, I was finding that some were not; once I started using these in-class activities to test class preparation, I found that the students did prepare more for class.

The Failures of the Grading System

Where this gamification system failed in this class was for grading. The first problem came with the inverted grading system. According to this system, students were not eligible for a D until they had earned about 60% of the available points and the optional activities meant that students did not earn points at the same pace. Therefore, when mid-semester reports came out, it was difficult to determine how to assign a grade fairly. The larger problem was that students did not know how they were doing in the class. Those students who were comfortable with gaming understood how to look at the larger system and see how they could continue toward an A, but many of the students weren’t used to looking at point systems.

One way of solving this would be to provide students with “future predictions” through a spreadsheet where they could fill in values for future assignments to see where they would fall. The reality of this system, however, is that it is a shallow redistribution of a traditional point structure. Many of the students were not comfortable with the idea of starting at 0 and working up, and the confusion it created was not worth it. I took a vote in class, and only about 15% wanted to stay with this structure, so the class was shifted to a more traditional grading structure.

Another failure came in the use of optional assignments. The class was designed so that students could choose the grade they wanted to pursue by selecting how many optional assignments they chose to take. In order to avoid students producing a flood of optional assignments at the end of the class, there were five opportunities during the class where students could turn in one of the optional assignments. Between the required assignments and the in-class activities, students could earn an 80%; the reality was that students only doing the required assignments would have some troubles and end up with a C. Many students chose to not take on the optional assignments, especially early in the class. As one student commented, “I found that I would put off the optional assignments in this class to work on required assignments for other classes.”

As the class went on, I tried to help the students realize that if they wanted an A or a B, they needed to do some of the optional assignments. Some of the students got the message, while others still did not. Before the last few weeks, I laid out final grades for the students and added additional opportunities to submit an optional assignment. Some students still chose not to take on the optional work. One student said that “I encouraged students in the class to be lazy by not requiring them to turn in all of the assignments.”

In the surveys, over 90% of the students said that they did not like the structure with optional assignments, and on the syllabi that student groups created for future classes, only one out of eight had an optional assignment structure. A number of the students said the optional assignment structure was unfair: “Since I got an A on all of the required assignments, I should get an A in the class.” When the students were working on their syllabi assignment, they were given 4 other syllabi from other sections of the same course, and I pointed out that to earn an A in any of the classes required same amount of work; the only difference is that I allowed them to do less work if they wanted to pursue a lower grade.

I hypothesize one of the reasons the optional assignment structure failed was that this was a required course that many of the students did not want to take. If this was a course on a topic that students had more of an intrinsic interest in, I predict they would have been more interested in taking on these optional challenges. Another problem was the use of the word “optional”; many students think of “optional” as “valueless” or as “extra credit” (meaning they can still get an A without doing this optional work).

One resolution for this, especially in a required course, is to give students a choice of assignments, but still require an assignment to be turned in. This would still have the benefits of giving students agency in what they take on, but it makes it clear that the students should turn something in if they want to get a good grade in the class.

Through these grading failures, I realized one of the problems with an overly flexible gamification system is that it does not provide the encouragement that weaker students need. Students who are self-driven will succeed in a space with optional or required activities, but students who are not as self-driven will be more likely to fail in a system with too much freedom. This problem is made worse when students are engaging with a game-based system that is unfamiliar to them and in a course that they aren’t very interested in taking in the first place. For my future gamification attempts in the classroom, I plan to focus on gamification elements that are designed to help the weaker students to succeed. Stronger students will still find the space to explore, but the underlying system needs to ensure that the weaker students get the support that they need.

One grading element based on play-based concepts that was successful is that of allowing students to re-do an activity. One of the concepts behind play and games is that they are based in failure; learning occurs by trying something, failing, reflecting, and trying again. In this class, students were allowed to re-do assignments on specified dates. This worked quite well, as it gave weaker students the support needed to help them achieve in the class while not getting in the way of the stronger students. Students re-doing an assignment always improved, and it was encouraging to see the students grow and improve.

The growth through this failure-safe space was so encouraging that it is the centerpiece for one of my current courses. For each assignment, students will earn a Gold badge, a Silver badge, or no badge. If the assignment is of the level of quality that it would be acceptable in the workplace, it will receive a badge. If not, the student will have one week to re-do the assignment to attempt to earn the badge. This way, students can focus on re-doing assignments until the badge is earned. The gold and silver qualification will be used at the end of the semester to determine final grades. This concept could be replicated in a traditional grading structure by offering only the grades of A, B, or re-do, but students may be frustrated that they can’t just earn a C and move on to another assignment. The badge concept makes it easier to enforce a minimum level of quality for these assignments.

Creating a failure-safe space based in the concept of play allows students to feel more comfortable taking on difficult projects. By setting a high bar and encouraging students to try something challenging, many students are rising to the expectations. The quality of the submitted work under these new systems is higher than it was under the older systems. Few students need more than one re-do attempt to accomplish their tasks. However, this has created a much heavier grading and administrative burden. At any point, I am dealing with a combination of both new submissions and re-dos from different classes, so there is a never-ending stream of grading.

Conclusions

Much of the advice on adding a game-layer to classroom management is coming from instructors teaching a game-related course. The students in these courses are going to be comfortable with game mechanisms and understanding game-based systems. When applying these game layers to a non-gaming course, instructors need to realize that not all students are able to quickly understand a new scoring system. In these cases, the types of gamification selected should be that which is most likely to change behavior and raise engagement without also introducing confusion. Game elements should be selected that support and encourage the weaker students in the class, as the stronger students do not need as much assistance.

Adding a narrative element to a class, especially if the students have some agency in creating their part in the story, can create motivation for students. On the other hand, using a narrative that doesn't support the concept of the class and feels "tacked on" will lose its charm quickly and can get in the way of learning objectives. Using unexpected rewards that are designed to highlight desired behavior can help more students adopt that behavior; however, relying too heavily on rewards can make students less interested in engaging in that behavior when that reward is absent. Badging systems can be useful for students to conceptualize specific hurdles to reach, and allowing students to create passion badges for things they are proud of and achievements for other students can encourage a more supportive environment.

Giving students choices can empower them in creating their own classroom experiences, but giving them options to not do work will create opportunities for weaker students to fall through the cracks. Non-traditional grading systems should be used only if there are true benefits for doing so that outweigh the confusion they create. Using a failure-based model where students can re-attempt work can allow weaker students to learn, improve, and gain confidence. Allowing students to create their own path for learning in a negotiated personal contract can be quite empowering for the student and result in very positive results.

No matter what gamification systems are used, it is important for the instructor to realize that they increase the administrative overhead for a course. Each of these aspects adds something new that an instructor must track, something different that must be explained (multiple times), and extra time in the classes for negotiation and re-attempts of assignments. Because of this, instructors should implement only those gamification elements that are most likely to be meaningful to the students and have a positive impact on their learning.

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Online Communities Making a *Mass Effect*: From Affinity for Games to Identities for Professionalism

Amanda Ochsner, University of Wisconsin-Madison, aochsner@wisc.edu

Abstract: A great many adolescents and young adults participate heavily in online affinity spaces around videogames. Committed contributors spend upwards of 20 hours each week researching, writing, and editing to contribute to wikis, fan fiction stories, and other literacy-rich online spaces. Many of these individuals hope to leverage their work toward careers as professionals in the gaming and publishing industries (Ochsner & Martin, 2013). Through ongoing case study interviews, this study explores the goals and trajectories that these writers form, using Miller and Slater's (2000) *expansive potential* and *expansive realization* as lenses for analysis. As a part of a broader trajectory, the goal of this research is to reveal how educators and industry professionals can support young affinity group leaders as they work to establish and build careers as professionals.

Introduction

Many young people today are more passionate about their interest-driven activities around media such as videogames than they are about their educational experiences and perceived career trajectories (Gee, 2007; Gee & Hayes, 2010; Steinkuehler & King, 2009). Yet activity around interest-driven spaces is not always what we might characterize as all fun and games. Active producers in interest-driven spaces such as wiki and fan fiction websites spend significant portions of their time researching, writing, and editing—skills that are valued both in schools and many professional fields (Steinkuehler & Duncan, 2008). Members of these communities frequently seek out project-based and self-directed opportunities (Lammers, Curwood, & Magnifico, 2012). Some individuals are content to do this work purely for leisure, but others hope to pursue work requiring similar skill sets professionally. However, the roadblocks to gaining a job in the games industry or in writing, editing, and research fields are numerous—including disaffiliation with school, failure to be admitted to competitive post-secondary programs, and a lack of direction upon completing academic programs—and young people find themselves unable to make progress toward accomplishing their career goals. Instead of examining the learning that goes on in schools, in this research I look to the spaces where adolescents and young adults already channel so much energy and effort—the websites and online spaces around popular videogames.

Studying active producers on wiki and fan fiction sites around the popular role-playing videogame franchise *Mass Effect*, I explore how participation in these spaces leads contributors to forge identities that inspire and enable them to pursue professional career trajectories. Identity-formation and skill acquisition (such as becoming a stronger writer or editor) are reciprocal processes, building on one another to support individuals to take active steps toward achieving their long-term professional goals. Instead of making assumptions that these activities are always just-for-fun—or worse, a waste of time—researchers, educators, and industry professionals could work to help young people leverage their literacy work in online affinity spaces toward professional career goals. The recent report from the Connected Learning Research Network cites active participation in online interest-driven communities as one of the digital era's best hopes for addressing growing issues such as the achievement gap affecting African American and Latino populations, as well as increasingly growing gaps between working class and upper income families. Because they foster engagement and offer social supports for interest-driven learning, online affinity spaces are ideal sites for exploring equitable ways to offer better opportunities for adolescent and young adult learners (Ito et. al, 2013).

Literature and Theoretical Framework

Interest-driven online spaces around games and other media—including forums, wikis, fan fiction sites, and others—function as affinity spaces (Gee, 2004) and as sites of participatory culture (Jenkins, 2006), forming a constellation of literacies (Steinkuehler, 2007) and information (Martin, 2011). As affinity spaces, videogame wikis and fan fiction sites provide participatory spaces of information and content exchange for informal learners with a shared interest and willingness to engage in collaborative activity (Black & Steinkuehler, 2009; Gee, 2004). Squire (2011) cites participatory learning spaces as places that encourage the development of unique expertise through peer-to-peer learning and apprenticeship. Gee (2004) poses that interest in the topic that an affinity space is centered around is the primary motivating factor for most participants. However, Jenkins (2007) suggests that it is not necessarily passion for the media franchise that motivates participants, but rather it is the community that matters. On a similar note, Davies (2006) argues that online affinity spaces offer opportunities for *reciprocal teaching* and *learning partnerships* where the enjoyment of learning is secondary to the satisfaction people get from engaging in collaborative creation of products that are enjoyed by the entire community. Regardless of the initial and ongoing motivations of contributors on these sites,

In their ethnography of Internet practices among Trinidadians, Miller and Slater (2000) examine the ways in which individuals in the modern age forge their life trajectories. They outline two identity shifts that they observed in their participants based on their online practices. The first they termed *expansive potential*. When experiencing expansive potential, "people glimpse quite new things to be" and the Internet acts "as a mode of imagining the future" (p. 13). Essentially, the Internet acts as the means by which individuals are able to expand on who they believe they have the potential to become. The other phenomena they observed they called *expansive realization*. They describe a process of Internet practice "helping people to deliver on pledges that they have already made to themselves about themselves" (p. 11). Expansive realization can refer to re-attaining a state that had once been realized and then lost, or realizing a goal that was projected but not yet attained. Here, the focus is on an expansion of existing identities, with an emphasis on "finding oneself" and "taking up one's rightful place" (p. 11). Through case study interviews, I identify two aspiring professionals who experience states of expansive realization and expansive potential as a result of the literacy and professional development practices they engage in around online *Mass Effect* communities.

Methods & Data

Communities of Study

For my research I chose to study the sites focused around the popular single-player role-playing game franchise *Mass Effect* from developer Bioware. At the time of data collection, the second game in the series had been released and was seeing both commercial and critical success, and the final part of the trilogy was due to come out the following spring, so there was a lot of excitement about the game and the online sites dedicated to the series were especially active. To recruit research participants, I turned to editors on the Wikia *Mass Effect* wiki, the largest wiki resource around the *Mass Effect* series, as well as authors on fanfiction.net, which has the largest compilation of fiction stories around the series.

Case Study Interviews

The first phase of the project consisted of conducting interviews with active editors on the *Mass Effect* wiki and writers who compose novel-length fan fiction pieces about the series. I chose interviewees by means of purposive sampling, selecting only those individuals who were especially active and influential in their respective communities, with specific criteria being number of edits made on the wiki and story word count for the fan fiction writers. All interviews were conducted online, primarily through email correspondence with the interviewees. After conducting interviews with between three and five individuals each from the *Mass Effect* wiki and with *Mass Effect* writers on fanfiction.net, I selected two focal participants, one wiki administrator and one fan fiction writer, to function as the study's primary case studies, enabling me to conduct follow up interviews as they became necessary. Throughout the rest of the paper I call the wiki administrator Erik and the fan fiction writer Raina.

Both of the selected case study participants were willing to provide especially detailed information about their motivations and writing practices, as well as how their writing and editing responsibilities fit into larger life contexts relating to career and family. In choosing to focus on just two subjects, I could gain a more holistic understanding of the individuals under study. I was able to determine their motivations, identify the skills they are developing, and understand how their work in the interest-driven online spaces relates to long-term professional goals. Conducting follow-up interviews for a period of more than nine months after my initial contact correspondence allowed me to gather information and data about the participants' ongoing projects and emerging practices, as well as to follow up on the progress they were (or were not making) toward their stated goals and trajectories.

After completing about five interviews and follow-up interviews with both Erik and Raina, I utilized the qualitative coding software NVivo to code the interview responses in order to identify and categorize the major themes that emerged from my conversations with both participants. Analysis revealed four major prevalent themes: roadblocks to continued progress; why the community worked initially (short term); what the community experience offered over time (long term); and connections to larger goals and overall trajectory. See Table 1 for how data from the interviews with Raina and Erik conforms to the major themes.

Community Supported Progress	Erik: Wiki Editing	Raina: Fan Fiction
Roadblocks to Continued Progress	Could not find job Excess of unproductive time Was not making progress toward long term industry goals	Struggled to find time for writing Few opportunities to receive feedback on work Pressure to create an “epic world”
Why This Community Worked Initially (Short Term)	Deep interest in *Mass Effect* Knew Wikia sites to be a quality source for info Desire to learn wiki-editing skills Got a laptop, enabling increased participation Had time to commit to wiki Related to (though vaguely at first) long term industry goals	Games offer inspiration for story ideas Pre-existing story universe Other readers and writers with similar interests Anonymity offered freedom for experimentation Ability to post stories in mid-progress Ability to focus on desired skills: character, voice, and tone
What the Community Experience Offered (Long Term)	Time management skills Experience with mediating conflict Ability to collaborate on projects Opportunity to work as a leader in the community Plethora of experience with writing and editing	Discovered talent for filling in the “blank pages” Dramatic improvement of writing skills Found like-minded audience Got over fears of being good enough Practice before going out into publishing world

Connections to Larger Goals and Trajectory	Time management, conflict mediation, collaboration, and leadership relevant industry skills	Improved on specific skills, fulfilling long term writing goals
	Writing, editing, and communication skills relevant industry skills	Gained confidence through having an audience that appreciates her work
	Dedication to community helped instill greater commitment to goals for a future in the industry	Enabled her to take the next step in her trajectory—publishing original fiction

Table 1: Major themes based on codes devised from analysis of interview data.

Results & Conclusions

Erik and the *Mass Effect* Wiki

Erik is one of the most active administrators on the *Mass Effect* wiki, putting in between 20 and 40 hours each week. He has aspirations to work in the games industry one way or another, but found himself unable to make progress toward this goal. Unemployed and believing himself to have an excess of free time, Erik began contributing to the wiki because he wanted to do "something productive." And productive his efforts have been—the wiki has put Erik back on track with pursuing his professional goals. He is currently working toward two associates degrees, including one in game design. Erik's wiki work involves mediating conflicts, enforcing and negotiating rules and community norms, and managing his time across multiple demanding activities and projects. His work with the game and wiki has enabled him to find a greater sense of purpose that helps drive the goals that are emerging out of his schoolwork.

Miller and Slater's term expansive potential—where online practices enable people to imagine new futures—describes Erik's experiences quite well. While previously game design had been an abstract goal for the future, he has begun to take concrete steps toward this end. Pursuing a degree in game design, Erik will be transferring from his community college to a four-year university for a bachelor's degree after just one more semester. He hopes to be able to use both the game design experience and the wiki work to gain a job in the games industry. His involvement with the community has played a major role in helping Erik to shape and articulate long-term professional goals for his life, and then the ability to begin pursuing those goals. Figure 1 shows Erik's progression from simply having an abstract goal out of his gaming identity, hitting roadblocks to prevent him from making progress toward this goal, and then finding ways to use the wiki to mediate these struggles and get back on track with his trajectory.

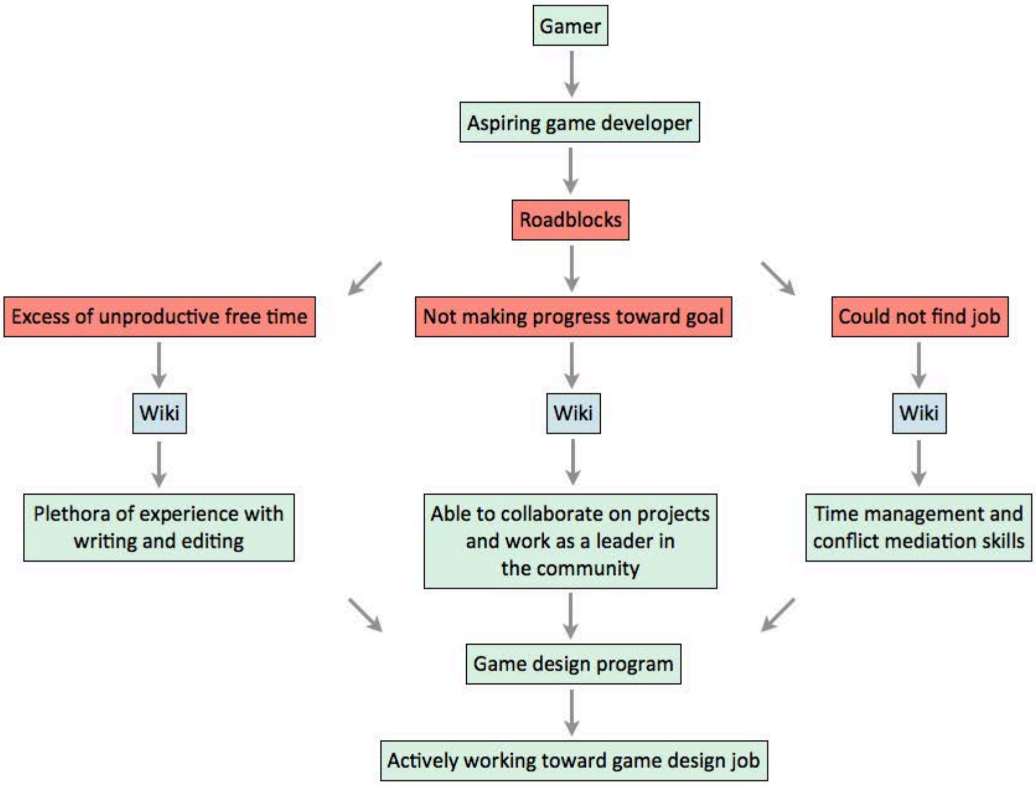

Figure 1: Erik's progression of expansive potential, mediated by editing on the wiki.

Raina and *Mass Effect* Fan Fiction

The second case study for this paper focuses on Raina, a writer who composes novel-length stories set in the *Mass Effect* universe. Raina is a stay-at-home mom who studied creative writing as an undergraduate and graduate student. Now she writes fan fiction as a way to keep her writing skills polished. In school she says she had limited time for working on personal writing projects, a roadblock that has only gotten more challenging as she has become a mom. She describes not being able to write as consistently as she wanted. She says:

> I felt I ought to write to a certain audience and write a certain kind of story. I was having so many issues about how I *ought* to write that I found I couldn't just *write*. [emphasis hers] I was also getting caught up in trying to come up with the epic world I felt all fantasy stories should have (location, backstory, characters, sequel ideas, etc.). And I just couldn't get the first few chapters of the first book down.

This hurdle of creating an entire world from scratch is one that *Mass Effect* was able to help Raina temporarily bypass so that she could focus on improving specific writing skills.

Another benefit that has come out of writing fan fiction is having an audience for her work. After what she describes as "long hours in debate with myself about whether what I had to say was good enough or if I would find a publisher or an audience," with fan fiction she was able to just write and post. She says, "The fact that people like my work and my writing style…made me realize I do have an audience out there." This led her to be more confident: "I realized that by writing the kind of story I wanted to read, the audience found me. I didn't have to change myself to make my stories more palatable."

Raina's experience shares many similarities to Erik's but, since she was a bit farther along in her trajectory to becoming a writer (having already earned creative writing degrees and having more experience), she is more articulate about how fan fiction has helped her to work toward her long term publishing goals. For Raina, writing fan fiction both helps her to re-identify as a writer with an audience and to look forward to fulfilling her long-term goal of creating original fantasy novel-length stories. She characterizes her fan fiction writing as a practice exercise. Unlike Erik, for whom the wiki seems to have enabled the first steps toward achieving his goals, Raina was able to articulate what she wanted from fan fiction early on, and all along planned specifically to use it to accomplish her professional goals.

Ultimately, Raina's experience contains a bit of both expansive potential and expansive realization. She had re-alized an identity as a writer in her days at the university, but even then had not been able to work on an original novel-length work. Fan fiction has been a step in a trajectory of fulfilling long-term life goals for Raina—one that en-abled her to finally be able to try her hand at writing her original fiction and publishing it online for a real audience. Figure 2 shows how writing fan fiction has enabled Raina to move past some of her writing roadblocks, putting her back on track for writing her own original fiction novels.

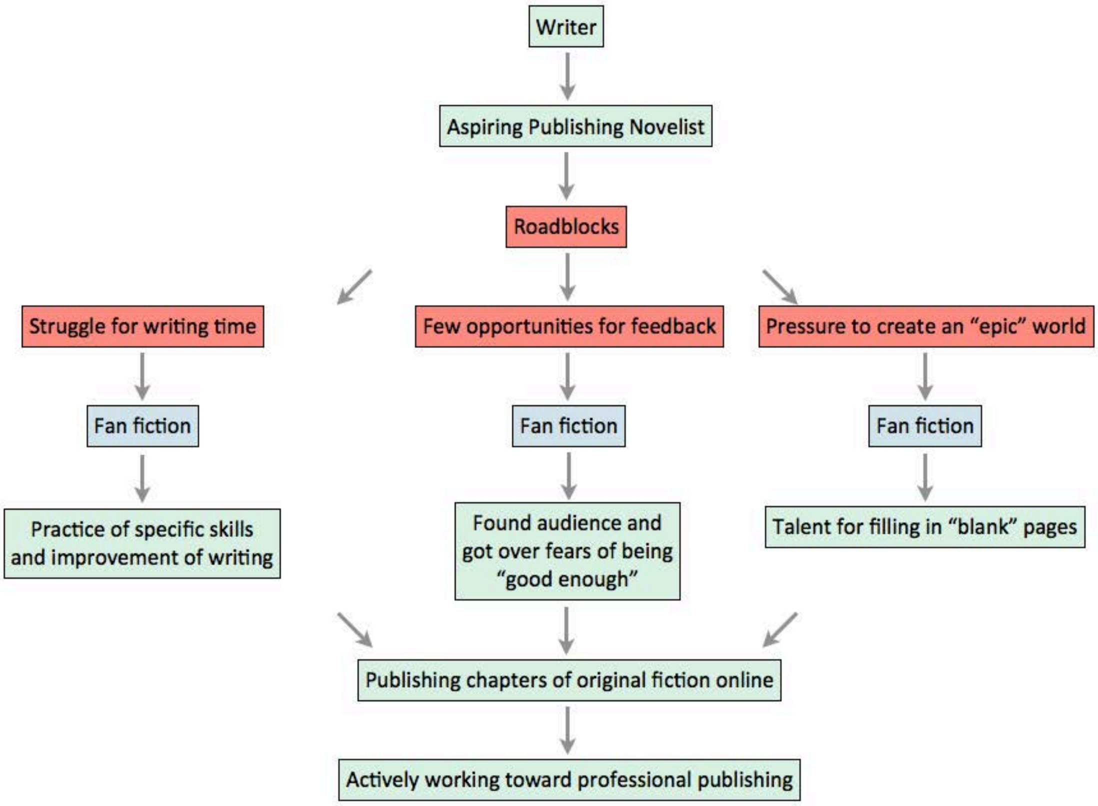

Figure 2: Raina's progression toward expansive realization, mediated by writing fan fiction stories.

Significance of the Research

For participants in these spaces, the work of participation and the practicing of skills turns into a process of shap-ing and shifting identities. In addition to acquiring useful professional skills, the more active contributors begin to articulate new identities and imagine new futures. Since we live in a world where learning is often confused as being inextricably tied up in school, we need to pay attention to places where people find opportunities to learn voluntarily and work collaboratively to create something they care deeply about. Educators could do a lot for young people through understanding the value of these efforts, and finding ways to help them leverage those skills and experiences toward their professional career goals. Industry professionals could also benefit from being familiar with this work because the results presented here suggest that participating in online affinity spaces around games and other media plays a significant role in adolescents and young adults' preparation to enter professional fields such as the publishing and games industries.

The more we understand the processes that people go through as they pursue their interests in such spaces, the more we can help facilitate both improved learning outcomes and opportunities for the participants to be able to utilize their skills and experiences to pursue longer term life goals. Online affinity spaces such as these can offer a lot to their participants, but they also give these contributors a lot of skills and experiences to offer academic programs and potential employers. However, there is work to be done before the majority of such creators will be able to leverage their skills in such a way. The current professional environment values official education credentials over work in interest-driven spaces such as those outlined in this study. However, as we have seen here, work in such spaces combines with formal education in ways that enables participants to more clearly form and articulate their goals and offers some of the motivation and inspiration to make directed, substantive progress toward those goals.

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ADAGE (Assessment Data Aggregator for Game Environments): A Click-Stream Data Framework for Assessment of Learning in Play

V. Elizabeth Owen, Richard Halverson
Games+Learning+Society Center at the University of Wisconsin-Madison
vowen@wisc.edu, halverson@education.wisc.edu

Abstract: A central challenge to educational videogame research is capturing salient in-game data on play and learning. ADAGE (Assessment Data Aggregator for Game Environments) is a click-stream data framework currently being developed by the Games+Learning+Society group to facilitate standardized collection of in-game assessment data across games. ADAGE integrates core game design structures into a click-stream data (telemetry) schema, which is then seeded with context vital to informing learning analyses. These data can be used to identify patterns in play within and across players (using data mining and learning analytic techniques) as well as statistical methods for testing hypotheses that compare play to content models (cf. Loh, 2013; Halverson & Owen, in press). ADAGE assessment structures also inform iterative, data-driven design of GLS games. Overall, ADAGE provides a standardized game telemetry framework with a rich, method-agnostic data yield, efficient enough to have scalability, and flexible enough to use across games.

Introduction and Theoretical Framework

In educational game research, a central challenge is capturing salient in-game data on user experience through the lens of play and learning. A typical approach has been to treat the game as a black box, focusing on data collection via pre- and post- measurements; in relying solely on this, however, we lose the unique characteristics of games as a learning tool. James Gee has suggested that games themselves provide excellent learning assessments. Well-designed games reward players for mastering content and strategies, scaffold player activities toward greater complexity, engage players in organized social interaction toward shared goals, and provide feedback that allows players to monitor their own progress (Gee, 2005). Rather than ignore the motivating and information-rich features of games in capturing learning, designers need to attend to the ways in which gameplay itself can provide a powerful new source of assessment data. This requires thinking of games as both intervention *and* assessment; and developing methods for accessing in-game data with a consistent, versatile, context-rich framework for use in learning analysis.

Well-designed games are examples of situated learning environments in which learning exists *in situ*, inseparable from environment or context (c.f. Brown et al., 1989; Greeno, 1997). Virtual game worlds have been shown to provide a powerful environment for learning, supporting apprenticeship and collective higher-order thinking skills (Steinkuehler, 2004; Steinkuehler & Duncan, 2008). Videogames afford this environment by providing *designed experiences* in which players explore worlds to understand how knowledge and skills interact in a context (Squire, 2006). From a player perspective, good video games include just-in-time information and cycles of expertise that scaffold play experience. The data channels available to the player act as formative feedback displays which inform play. To maintain this immersive context for learning, good games consist of ongoing assessment balanced with engaging mechanics and narrative (Squire, 2006). Games can thus provide an experience which is distinct from – but relies upon – the core design mechanics of the game. Game design icon Jesse Schell is careful to distinguish early in the design process that “the game is NOT the experience” (2008, p. 10; see Figure 1). Salen and Zimmerman assert that “the careful crafting of player experience through a system of interaction is critical” (2008, p. 61). Additionally, in moments of transgressive play, users often interact with the gamespace in unanticipated ways (Salen & Zimmerman, 2008). How, then, can we further explore the connection between design, interaction, and experience? Applied specifically to educational games, how does it then connect with in-game data collection for assessment of learning?

The GLS approach to bridging these worlds is ADAGE (Assessment Data Aggregator for Game Environments), a click-stream (telemetry) data framework that looks inside the black box of educational games. ADAGE identifies key gameplay verbs as occasions for interaction, providing a click-stream data framework for collecting evidence of learner trajectories. In looking at in-game data, we avoid the “Heisenburg” problem of usertesting – that a user experience “cannot be observed without disturbing the nature of that experience” (Schell, 2008, p. 18). As Val Shute notes, telemetry-based assessment can be a “quiet, yet powerful process” through which we can unobtrusively observe player patterns (2011, p. 504). However, with the affordance of subtlety comes the problem of abundance; log files from digital spaces can produce millions of data points with little to no context (c.f. Baker & Yacef, 2009). ADAGE addresses this core question specifically for educational games: how do we identify, record, and output click-stream data salient to learning analysis?

ADAGE (Assessment Data Aggregator for Game Environments)

ADAGE was designed to transform game-based log file data into evidence of learning. It articulates a bridge between educational game design and player experience, which is then structurally integrated into a framework for an otherwise inchoate mass of log data. ADAGE organizes click-stream data framework that allow developers and researchers to trace trajectories of player experience by tracking interaction with core mechanics in the educational gamespace. It articulates key mechanics for recording (or "tagging") in the game data, and tags concurrent instructional game cues and gameworld context. The ADAGE tagging procedures are developed to create minimal interference with the development process, yet to yield data rich enough to be make inferences about learning. Because it builds on features core to educational game design, ADAGE is flexible enough to use across genres, and is currently implemented in four vastly different GLS games.

Below, we will identify and describe ADAGE assessment mechanics and telemetry features. Together these layers create context-rich raw click-stream data that can be filtered and processed data into sequential blocks or performance indices, facilitating the feature engineering process vital to later analysis.

Assessment Mechanics

Assessment mechanics are structures built into the game that allow for research on play and learning. Understanding game-based learning requires two levels of assessment mechanics: one to trace the paths players take through a game, and the other to access the player experience of game play (Schell, 2008). Squire asserts that games as designed experiences (2006) provide endogenous engagement (Costickyan, 2002) for the player through "roles, goals, and agency" (Squire, 2011, p. 29). Thus, in learning games, there can two core kinds of designed mechanics: one set related to progression through the gameworld (as an engaging learning context [Gee, 2007; Salen & Zimmerman, 2008]); another may be designed as more direct measures of the content the game is trying to teach (e.g. Clarke-Midura et al., 2012). Ideally, these also overlap; good educational games meld learning mechanisms with the core mechanics of the game, where gameplay itself is the only necessary assessment (Gee, 2012; Shute, 2011).

The ADAGE framework identifies underlying game mechanics for which serve as core occasions for player interaction. There are three base types of Assessment Mechanics: *Game Units* (capturing basic play progression), *Critical Achievements* (formative assessment of content), and *Boss Level* (naturalistic summative assessment). As "Assessment Mechanics", they serve as data-collection (or assessment) anchor points, which yield data informed by core educational game design structures. This terminology also parallels concepts of formative and summative assessment in formal learning environments (Harlen & James, 1997), and formalizes them as powerful elements of game design (c.f. Gee, 2012).

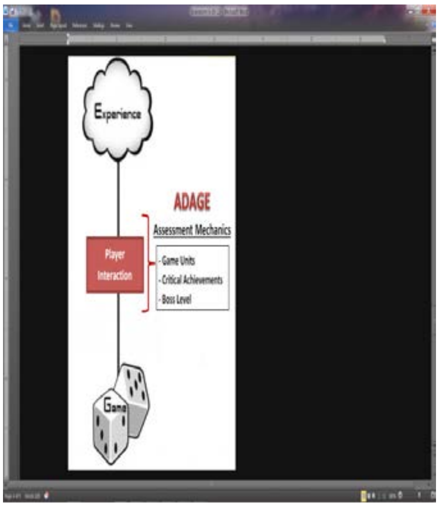

Figure 1: Schell's distinction between player experience and game design (2008, p.23); ADAGE assessment mechanics as bridge between.

Through Assessment Mechanics (AMs), ADAGE operationalizes player interaction (Salen and Zimmerman, 2008) as the vital link between experience and game design (Schell, 2008; Figure 1). These three core AM types can easily overlap within a gameworld; they are not mutually exclusive, though they have distinct categories. Additionally, every game does not have to have all AMs in order to use ADAGE. In this section, we will describe each mechanic, and connect it to ADAGE's underlying telemetry structure.

Game Units. The game Units represent the core progress mechanic of the game. For example, in a game like *World of Warcraft (WoW)*, the core unit is quests. By definition, game units have the property of being a repeating, consistent vehicle for making progress through the gameworld. Units can also be part of a hierarchy – for example, one set of quests may make up a particular map area, and completing all the maps means finishing the game. Thus, from broadest to smallest, game Unit hierarchy might be: game-map-quest. The idea behind Units is that they are flexible enough to work across genres; for example, in Tetris, the core Units are level completion and placement of shapes (different from *WoW*'s quest structure). Currently, ADAGE Unit structure is applied to five different GLS games (*Progenitor X, Fair Play, Anatomy Pro Am, Tenacity,* and *Crystals of Kaydor*) each with different genres and Unit types. The concept of Unit is logistically integrated into ADAGE's telemetry, with the term specifically connected to click-stream tags in ADAGE's API. The Unit AM informs user experience in setting base interaction with the game environment, a "vital component of design and interaction" (Salen & Zimmerman, 2008, p. 51).

Critical Achievements. Critical Achievements (CAs) in ADAGE are direct formative assessment slices of the content model (what the game is trying to teach). They are moments of direct content measurement within the context of normal gameplay. Seamlessly woven into the fabric of the game, CAs use naturalistic game mechanics to measure underlying educational content. For example, *Fair Play* is a GLS game which teaches about implicit bias in graduate education settings. In one *Fair Play* CA, the player needs to correctly identify a given bias to another character in order to progress. This is a direct demonstration of bias knowledge (as opposed to indirect movement through the learning context, like in game Units). Evidence Centered Design (ECD) is an analytic framework which focuses entirely on CA-like structures – direct demonstration of content knowledge (Mislevy & Haertel, 2006), recently applied to virtual spaces (e.g. Clarke-Midura et al., 2012; Behrens et al., 2012). For this reason, the CA data structure aligns very well with ECD-specific analyses. CAs (analogous to the "task model" in ECD) are intended to be one kind of direct content assessment embedded in gameplay, looking at selected moments of performance as learning measures. These moments can be compared throughout gameplay to give one snapshot of learning growth; moving beyond a task model, they can also be triangulated with ADAGE mechanisms like broader gameworld interaction data (Units), boss level performance, and pre-post learning measures. Although CAs are a great educational game design feature that lends to robust learning analysis, games don't have to contain CAs to use the ADAGE framework. The concept of CA formative assessment is manifested logistically in ADAGE's click-stream data structure, with CA-specific terminology in the API. Ultimately, CAs are a unique feature of educational games, and capture both learning AND play dynamics in the user experience.

Boss Level. The Boss Level is a final stage of a game that is a culmination of skills learned in gameplay. It is a naturalistic summative assessment, and can include both learning and progress mechanics (like CAs and Units). Gee notes that powerful embedded assessment occurs in "boss battles, which require players to integrate many of the separate skills they have picked up" throughout the game (2008, p. 23). Games are an ideal medium for this summative assessment, he asserts, since they can provide just-in-time performance feedback with low cost of failure (Gee, 2007). Thus, summative assessment mechanics in games can give us an unobtrusive measure of performance (c.f. Shute, 2011) in an agency-inspiring context (Squire, 2011) in which players receive instant feedback and appealing opportunity to improve (Gee, 2007). By formalizing the Boss Level as an Assessment Mechanic in ADAGE, we encourage deliberate inclusion of summative assessment in game design, and provide corresponding telemetry API structures for implementation. Interaction in the Boss Level shapes user experience as a culminating game encounter, and has also proven significant in ADAGE studies on gameplay progression and learning. For example, in *Progenitor X*, a GLS game about regenerative biology, strong performance in the boss level was predictive of learning gains (Halverson & Owen, in press).

Telemetry Framework

The Assessment Mechanics, informed by game design and assessment research, create a conceptual framework for identifying interaction data. The next ADAGE step moves us from concept (AMs) to implementation (telemetry). The telemetry framework hinges on the AMs to create a schema of context-rich data tags for implementation in the game code. Interpretation of student interaction often hinges on the context of the learning environment (in this case, the designed gameworld). The telemetry schema addresses this need by seeding the AM interaction data with vital contextual information.

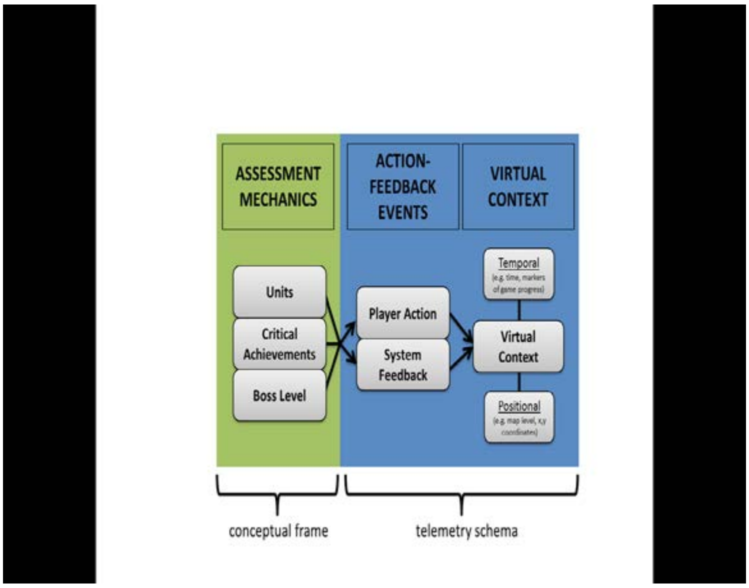

Figure 2: ADAGE Assessment Mechanics and telemetry schema.

The telemetry schema has two layers: an action-feedback layer, and a Virtual Context layer. First, for each Assessment Mechanic, it identifies two sources of direct interaction: user action, and system feedback. It articulates the vital action-feedback loop (c.f. Salen & Zimmerman, 2008) that comprises interaction between the player and the game. The second layer, called the Virtual Context, attaches important contextual information to each action-feedback event. The Virtual Context can include things like timestamp, map level, and screen x,y coordinates. These two layers work in tandem to provide context-rich telemetry data on AM-based gameplay trajectories (Figure 2).

One example of the applied telemetry schema is in the game *Progenitor X*. *Progenitor* is a puzzle-based zombie game about stem cell biology (playable from the footnote link). The core Units of the game are cycles of cell, tissue and organ creation. Table 1 applies the telemetry framework to a single cycle. In column 1, we identify the Assessment Mechanic – a Unit, specifically the first game cycle. Column 2 asks: for the start of that cycle, game cues are going on? To help the player begin, the game makes the start button flash. The feedback event becomes "Start button flashes". Next comes the corresponding player action for Column 2, which is "Player clicks 'start' button". Lastly, for each of the action-feedback events, we define the contextual information we need (column 3). To understand player progress, we attach information about which map the player is on, and elapsed time. Location of click is also recorded, in case heat mapping or place-based performance analysis is desired. The resulting Virtual Context is "Timestamp," "Map Level," and "x,y Coordinates."

Unit	Action-Feedback Events	Virtual Context
1st Cycle	Start button flashes Player clicks "start" button	Timestamp Map Level x,y Coordinates

Table 1: Telemetry schema example: *Progenitor X*

In implementing this framework, this process is completed for every sequential Assessment Mechanic in the game. In other words, each unit, critical achievement, and boss level section is laid out sequentially, then mapped to action-feedback events and Virtual Context. More detailed process information and templates are laid out in ADAGE's DevDoc, a working document for connecting ADAGE with new games. However, ADAGE's core telemetry structure is presented here, centered on the AM sequence, the action-feedback events, and the Virtual Context. Each of these elements has a counterpart in ADAGE code, mapping conceptual AMs to click-stream structures of user actions, system feedback, and the Virtual Context around each.

Raw Data. Essentially, ADAGE identifies core game design features that provide occasion for interaction. It then delineates a framework for tagging this data in the massive influx of click-stream input, and attaches systematic contextual information to each data point. This, in turn, produces an abundant stream of telemetry data informed by the game design structures. Raw ADAGE data contains all action-feedback data of each AM in the game, enriched with the telemetry structure's Virtual Context (Figure 3). The beauty of this rich stream is that it gives contextual data raw enough to be used in almost any analysis.

ADAGE Data Filtering

After the raw data from the telemetry schema is tagged, ADAGE features additional processing and filtering affordances. It can build in information about Unit bookends (e.g. the beginning and end of cycles), as well as create performance measures like AM success, failure, and repetition. Performance measures can be tailored to the research question; for example, one might be interested in Critical Achievement performance (for use with ECD), Unit progression (gamespace trajectory projection), or Boss Level success (in triangulation with a pre-post assessment on learning gains).

Feature Engineering & Analysis Lenses

ADAGE's context-rich data make ideal building blocks for feature engineering. Features are essentially variables of interest in the data, which can range from simple click locations to complex measures like accuracy over time. Features of interest across a variety of methods can be generated from ADAGE output, including evidence model performance (ECD), quantitative ethnographic data (c.f. Efferson et al., 2007), or sensor-free affect detectors (Baker et al., 2012).

The features constructed, in turn, can be used across a broad range of analysis techniques. Data lenses can include descriptive statistics, hypothesis-driven applied statistics, and machine learning techniques. For general descriptive stats, ADAGE data can be used for simple aggregation of behaviors in the gamespace, including figures of average elapsed time, number of units completed, time per level, etc. Hypothesis-driven applied statistics (used in methodologies like ECD) can use ADAGE data as dependent variables, independent variables, and covariates for use in associative or predictive modeling. Specific to educational games, this often means testing hypotheses that compare play to content models (cf. Loh, 2013; Halverson & Owen, in press). Lastly, ADAGE data lends itself to learning analytic techniques often used with big data sets. Recent "State-of-the-Art" reports in Educational Data Mining (Baker & Yacef, 2009; Romero & Ventura, 2011) articulate various machine learning analysis techniques used with log file data. These include Social Network Analysis, classification and regression trees, cluster analysis, Markov chain modeling, and Bayesian networks. GLS researchers have also utilized ADAGE data to create heatmaps of most frequently visited in-game areas.

Design Implications and Conclusion

By capturing trajectories of player experience via context- rich interaction with core mechanics in the educational gamespace, ADAGE connects design and user experience. It then extends that connection to a standardized framework for collecting salient click-stream data on play and learning. These data can be used to identify patterns in play within and across players (using data mining and learning analytic techniques) as well as statistical methods for testing hypotheses that compare play to content models.

ADAGE assessment structures also serve to inform iterative, data-driven design of GLS games. The articulation of formative and summative Assessment Mechanics inform core educational game design. ADAGE AM data are also utilized as well in the iterative data-driven design process. In the recent GLS Tenacity project, a collaboration with the Center for Investigating Healthy Minds, early usertesting telemetry informed design refinements during game development (Owen et al., 2013). Additionally, ADAGE data output can be used to inform adaptive tutorial help overlays, potentially providing pivotal support for learners in hotspots of game dropout or failure.

ADAGE bridges design and experience, while creating a standard framework for producing salient telemetry data of play and learning. It encourages best practices in iterative game design, specifically around integrated formative and summative assessment mechanisms in gameplay. Overall, it provides a standardized game telemetry framework with a rich, method-agnostic data yield, efficient enough to have scalability, and flexible enough to use across games. Through integration of content, design, and interaction data, design efforts like ADAGE model technology standards for transforming click-steam data into evidence for learning analysis.

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Learning with Portals: STEM Education Through Gaming

Cameron Pittman, formerly of the LEAD Academy Charter HS, cameron.w.pittman@gmail.com
Steve Isaacs, William Annin MS, stevei2071@gmail.com
Leslie Redd, formerly of Valve Software, leslieannredd@gmail.com

Abstract: Two teachers, Steve Isaacs and Cameron Pittman, discuss how they successfully engaged and motivated students with *Portal 2*, an award winning commercial video game by Valve Software. Steve, a middle school video game design teacher in Basking Ridge, NJ, uses the Puzzle Maker, the *Portal 2* world-building tool, to teach computational thinking and the iterative design process in his courses. Cameron, formerly a high school physics teacher in Nashville, TN, turned the Puzzle Maker into a virtual physics laboratory. Leslie Redd, the former Director of Educational Programs at Valve, joins them to discuss how she created a community of educators through the Steam for Schools "Teach with Portals" project, which provided free copies of *Portal 2* to educators and an infrastructure for teachers to collaborate. The session will focus on successes and challenges of using *Portal 2* in the classroom from the perspective of educators and the companies supporting them.

Session Overview

Portal 2, an award winning commercial video game by Valve Software, has entered the classroom as a popular teaching tool for mathematics, science and game design curricula. Two teachers, Steve Isaacs and Cameron Pittman, have successfully engaged and motivated students with *Portal 2* and its accompanying Puzzle Maker world-building tool. Leslie Redd, former Director of Educational Programs at Valve, joins them to discuss how classroom teachers are using *Portal 2*.

Steve Isaac's Classroom

Steve teaches a unit called "Portal 2.5," which uses the Puzzle Maker to teach computational thinking and the iterative design. The Puzzle Maker's ease of use allows students to focus on design, iteration, and computational thinking. Steve's students begin playing *Portal 2* to better understand how puzzle elements are incorporated into the game. Students are then presented with broken rooms, with which students have to create functional puzzles following a predetermined set of parameters. Students then create broken levels for others to fix. In the process, Steve's students create a functional room then consciously break it to present a challenge to their classmates.

Using their experience as a guide, students then create an original puzzle using the Puzzle Maker. Iterative design is a key component of this exercise as students recruit their peers to provide constructive feedback. The playtesting and feedback loop recurs several times with an emphasis on achieving an acceptable difficulty level. Students collaborate to create levels with increasing difficulty and coherent storyline.

Cameron Pittman's Classroom

At its core, *Portal 2* is a physics simulator. The laws of physics, like gravity and collisions, are built into *Portal 2*'s game world. Cameron turns the Puzzle Maker into a virtual physics laboratory this past fall as his students learn physics by developing, running and analyzing experiments they built within the Puzzle Maker (http://physicswithportals.com).

As Steve's students use the Puzzle Maker's ease of iteration to teach game design, Cameron's students use the Puzzle Maker to create, analyze, adjust and analyze custom physics experiments. Through a series of ten labs, Cameron's students build experiments that test everything from gravity and Newton's Laws through conservation of momentum and conservation of energy. In the process, Cameron's students collect and analyze virtual data through the same processes and procedures physics students use with real world data.

As part of their end of semester final project, Cameron's students create and describe custom levels that showcase three concepts they learned during the semester. Students write a physics word problem that is brought to life by one of the experiments from their final project.

Leslie Redd's Classroom Support

Leslie created a community of educators through the Steam for Schools "Teach with Portals" (http://www.teachwithportals.com) project, which provided *Portal 2* for free to educators and supports teacher collaboration. Leslie is currently the Governance Chair of the Games and Learning Publishing Council of the Joan Ganz Cooney Center at Sesame Workshop. She will also speak to the efforts of the Council and its members (experts from educational media publishing, children's media organizations, developers, researchers, policy & investment sector) to catalyze the consumer and educational marketplaces for learning games.

Gameplay Enjoyment, Gender, and 19 Individual Characteristics More Influential than Gender

John M. Quick, Arizona State University, John.M.Quick@asu.edu
Robert K. Atkinson, Arizona State University, Robert.Atkinson@asu.edu

Abstract: As the scientific understanding of player differences and gameplay enjoyment matures, it becomes necessary for games scholars to ground research trajectories in empirical findings, rather than long-held assumptions. Although observable differences between players may appear to exist along gendered lines, empirical evidence has not been so conclusive. Following a survey of the gameplay preferences, gaming goal orientations, and play habits of 301 participants, a stepwise regression analysis was undertaken to examine gender alongside several other potential predictors of gameplay enjoyment. In the end, gender did not prove to be a substantial predictor of gameplay enjoyment, while gaming goal orientations were the strongest predictors. The results of this study point to several promising variables that should be considered in continued research. Furthermore, this study reaffirms the need for games scholars to focus towards detailed individual characteristics that can provide deep insights into player experiences.

Introduction

Many game-related works have centered on gender (Heeter & Winn, 2009; Kafai, 2008). Popular games and gender topics include industry employment gaps (Gee & Hayes, 2010), avatars and identity (Hussain & Griffiths, 2008; Isbister, 2006; Williams, Consalvo, Caplan & Yee, 2009; Yee, 2008), and educational gaming (Annetta, Mangrum, Holmes, Collazo, & Cheng, 2009; Carr, 2005; Hayes, 2005; Heeter, Egidio, Mishra, Winn, & Winn, 2008; Wei & Hendrix, 2009). However, in empirical investigations of the gameplay experience, gender has played a dual role.

At times, gender has been used to show distinctions between players. Wood, Griffiths, Chappell, & Davies (2004) surveyed 382 undergraduates on their gameplay preferences and noted significant gender differences in 11 out of 13 categories. In a study of the preferences of German females, Hartmann & Klimmt (2006) concluded that the women generally preferred high amounts of social interaction, non-sexualized female protagonists, and low levels of violence in games. Greenberg, Sherry, Lachlan, Lucas, & Holmstrom (2010) surveyed over 1,000 high school and university students' gaming gratifications and genre preferences. Males rated all nine gaming gratifications significantly higher than females. Also, females preferred more traditional game genres (e.g. card, puzzle, arcade), while males preferred more physical (e.g. sports, fighting) and imaginative (e.g. strategy, adventure) games. Further, a common gender finding is that males tend to dedicate many more hours per week to gaming than females (Greenberg et al., 2010; Hoffman & Nadleson, 2010; Winn & Heeter, 2009).

At other times, gender has proven less substantial. After qualitatively analyzing an all-girls after school game club in England, Carr (2005) questioned prevailing, simplistic views on gender and gaming. She explained that, while it may be easy to generate data showing gendered game preferences, simply attributing such differences to a person's gender ignores the vast complexity of both gender and gaming preferences. Hayes (2005) shared these views and added that designing games for women should be similar to designing good games in general. Moreover, a study in which 33 participants played a commercial game, then reported their personality traits and affective responses, found no statistically significant gender effects (Chumbley & Griffiths, 2006). Likewise, a study of 74 primary school students were shown to improve their test performance after being exposed to a science learning game regardless of their genders (Annetta et al., 2009). Lastly, Bourgonjon, Valcke, Soetaert, and Schellens (2010) conducted a path analysis of 858 Flemish students' video game preferences and found that gender had a very weak main effect. Here, the gender effect was mediated by prior experience and ease of use.

Based on this body of literature, the present study aims to reevaluate gender as a potential predictor of gameplay enjoyment, not by itself, but as accompanied by several other promising variables. Thus, it is intended that the role that gender and other individual characteristics play in predicting gameplay enjoyment can be identified for the purposes of informing future research.

Method

The gameplay feature preferences, motivations, and usage habits of 301 participants from a large southwestern university in the United States were surveyed. The respondents ranged in age from 18 to 49 (*Mdn* = 21), with 84% being between 18 and 24 years old. In terms of gender, 29% were female, 70% were male, and 1% chose not to share this information. The participants came from a variety of fields of work and study, including engineering, science, psychology, humanities, arts, and business.

The survey instrument assessed respondents' game preferences, gaming goal orientations, and game usage habits. In the game preferences section, participants rated how important 41 features, such as *Realistic graphics* and *Online multiplayer*, were to their enjoyment of games. Feature ratings were made on a 5-point scale that ranged from *Not important* to *Extremely important*. Subsequently, the feature ratings were combined to yield an overall Enjoyment score, which provides an indication of how much each participant enjoys gaming in general. In the gaming goal orientations section, participants used a 5-point scale that ranged from *Not true* to *Extremely true* to rate 18 statements about their gaming motivations. These statements were adapted from the educational 3x2 goal orientation framework (Elliot, Murayama, & Pekrun, 2011) to fit a gaming context. Example statements include *To win on a challenging difficulty level*, *To do better than other players*, and *Avoid playing worse than I have in the past*. For each participant, factor scores were generated on the six dimensions of the 3x2 framework, including Task-Approach, Task-Avoidance, Self-Approach, Self-Avoidance, Other-Approach, and Other-Avoidance. In the game usage section, participants reported on a host of play habits variables, such as hours played per week, preference for play with others, frequency of play on different gaming consoles, and enjoyment of several game genres. Specific scales were used as appropriate for each game usage question. Survey responses were analyzed through a stepwise regression approach. The stepwise regression analysis was conducted using the *stepAIC* function from the *MASS* package (Venables & Ripley, 2002) in *R* (R Development Core Team, 2012).

Results

A bidirectional stepwise regression analysis was conducted to assess how well an array of potential predictors, including gameplay goal orientations, gender, and play habits variables, explain players' overall enjoyment of video games. In this analysis, the composite Enjoyment score was designated as the dependent variable. Meanwhile, 48 potential predictors were entered as independent variables. Potential predictors included the six gaming goal orientation factors, gender, and numerous game usage variables (hours played per week, frequency of platform usage, genre ratings, and so on). The stepwise regression procedure yielded a model with 19 independent predictors. The overall model was statistically significant and accounted for 83% of the variance in gameplay Enjoyment (R^2 = .828, adjusted R^2 = .816, $F(19, 273) = 68.93$, $p < .001$). The model and its predictors are summarized in Table 1.

Discussion

The stepwise regression analysis retained 19 of the 48 potential predictors. Most notably, all six of the gaming goal orientation variables were statistically significant predictors of gameplay Enjoyment. Indeed, the three strongest predictors in the model were gaming goal orientations: Task-Avoidance (motivation to avoid poor performance in games), Self-Approach (motivation to outperform one's past performance in games), and Other-Avoidance (motivation to avoid performing poorly relative to other players). Additionally, enjoyment of the Shooting and Sports genres were modest predictors of gameplay Enjoyment. Other modest predictors of gameplay Enjoyment included the number of companions that one prefers to play with (e.g. solo, one other, two others, and so on) and the age at which one began playing games. The remaining genre preferences, along with the frequency of use of different gaming platforms, were among the weakest predictors that managed to be included in the model. Surprisingly, the gender variable failed to make the model at all, which suggests that it is a rather poor predictor of gameplay Enjoyment relative to the other variables included in this analysis.

Predictor	b	SE	t	p
Task-Avoidance	.267	.033	8.133	***
Self-Approach	.254	.038	6.771	***
Other-Avoidance	.180	.036	4.955	***
Shooting Genre	.137	.030	4.501	***
Number of Companions	.135	.029	4.664	***
Task-Approach	.126	.025	4.368	***
Other-Approach	.122	.038	3.206	**
Age Began Playing	.122	.027	4.475	***
Sports Genre	.111	.028	3.976	***
PSP Platform Usage	.076	.026	2.927	**
RPG Genre	-.074	.029	-2.587	*
Self-Avoidance	.068	.031	2.177	*
Social Network Genre	.067	.028	2.363	*
Games Played Last Month	-.065	.028	-2.360	*
iOS Platform Usage	-.061	.027	-2.246	*
Gaming Skill	.058	.031	1.854	^
Arcade Genre	-.057	.027	-2.132	*
Smartphone Platform Usage	-.049	.027	-1.809	^
PS3 Platform Usage	-.043	.027	-1.591	^
Intercept	-.013	.025	-.505	^

***Table 2*: Stepwise regression model predictors, beta coefficients, standard errors, *t*, and *p* values. ***$p < .001$, **$p < .01$, *$p < .05$, ^$p > .05$.**

Conclusion

While much is made of gender theoretically in the field of game studies and observable differences between players may appear to exist along gender lines, empirical evidence related to gaming and gender has not been so resolute. A stepwise regression analysis was undertaken to examine gender along with several other potential predictors of gameplay enjoyment. Ultimately, in a model that included 19 predictors, gender was not one of them. On the other hand, all six gaming goal orientation factors proved to be significant predictors. In addition, a multitude of game usage variables were included in the model and showed varying degrees of importance. While this analysis was not intended to offer a precise model that can be used to predict gameplay enjoyment, it does provide insights into where fruitful future research can be focused. Gender is a broad, overarching variable that should not be expected to show substantial relationships with an intricate topic like gameplay enjoyment. In contrast, gaming goal orientations address the specific motivations behind why people choose to play games and game usage variables are detailed metrics associated with gameplay behaviors. Therefore, it is posited that researchers will derive a greater understanding of gameplay enjoyment by incorporating detailed individual characteristics into their studies, rather than generic, overarching demographic variables.

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Investigating A Supportive Online Gaming Community as a Means of Reducing Stereotype Threat Vulnerability Across Gender

Gabriela T. Richard, Christopher M. Hoadley, New York University
gabriela@nyu.edu, tophe@nyu.edu

Abstract: We explore the relationship between online gaming communities (which literature shows act as informal learning environments) and experience in game culture, which has been shown to be inequitable, harassing and otherwise unsupportive to certain players, particularly females. Specifically, this study explores the experiences of gamers in gaming clans, both explicitly gender supportive and not, to see if they can serve as protective spaces for vulnerable players. Ultimately, the goal is to inform the design of equitable gaming environments.

Introduction

In this paper, we explore online gaming communities for their potential benefit in increasing learning-relevant constructs around efficacy and identity through supportive structures. Hence, the paper builds off of current work on online communities, by discussing how socially supportive scaffolds can aid in increasing the equity of online gaming experiences, which have been cited as being disproportionately harassing and negative for females and ethnic minorities (e.g., Kuznekoff & Rose, 2012; Gray, 2012; O'Leary, 2012; Nakamura, 2007; Richard, 2013). Emerging research is beginning to explore how socio-cultural contexts and experiences are playing out through the greater gaming culture and online gaming communities (e.g., Gray, 2012; Kimmel, 2008; Nakamura, 2007; Richard, 2013; Searle & Kafai, 2009).

Gaming, Online Communities, and Learning

Some scholars have written extensively about how online communities formed around gaming can be "affinity" spaces (e.g., Gee, 2007; Squire, 2011; Hayes & Duncan, 2012). In this sense, communities and online spaces built around informal learning environments, such as learning about games, or learning about issues in gaming culture, become models for education because they provide participation in authentic contexts (i.e., participants as producers of content), often involving the exchanging of ideas, the development of mastery, and access to "experts" in related areas (Squire, 2011). Steinkuehler (2004) analyzed learning and mastery in MMOs as explored through the relationship between social interaction and game systems, finding that "genuine expertise" arises through learning with others. Voulgari and Komis (2010) found that games and online communities built around MMOs could allow for collaborative learning through a constructivist framework built around game mechanics and design, and communication and collaborative capabilities. Further research is emerging in the area of successful collaborations in youth-based online game-based learning (Aragon, Poon, Monroy-Hernandez & Aragon, 2009; Kafai, Fields & Burke, 2010; Kafai, Roque, Fields & Monroy-Hernandez, 2011). For these reasons, games and communities built around games are often proposed as a vehicle to support education.

Inequity in Game Culture: Bias, Harassment and Exclusion

However, researchers have cautioned that the unlevel playing field around gender and ethnicity, which often gets played out in online gaming spaces (Bertozzi, 2008; Kimmel, 2008), has created a culture of gender and ethnic harassment, which disproportionately disenfranchises certain players (Gray, 2011; Nakamura, 2007; Richard, 2013). While harassment directed at female players in gaming spaces has been widely known amongst gamers, it has only recently become part of larger public discourse. Websites like *FatUglyOrSlutty.com* and *NotInTheKitchenAnymore.com* started appearing in 2011 to document gender harassment in online gaming. Anita Sarkeesian detailed the extent of the sexual harassment, "visual misogyny" and abuse she received after she announced a fundraising campaign to make videos about common stereotypes of female video game characters; the abuse included threatening comments on *YouTube*, menacing alterations to her *Wikipedia* page, and sexually explicit images of her being raped by game characters (Sarkeesian, 2012). Coupled with the public display of sexual harassment directed at Miranda Pakozdi, the only female on a competitive *Cross Assault* team, during a live broadcast of the tournament, harassment became a topic of widespread concern beyond the game community (O'Leary, 2012). Further, in a recent study, Kuznekoff and Rose (2012) found that females were three times more likely to be victims of harassment online through voice alone, despite what was said, or player ability.

Figure 1. Typical harassing messages received from players. Retrieved from *fatuglyorslutty.com*.

Inequity as Bias and Stereotype Threat

Research in the area of gender and digital games hypothesized that games can increase participants' interest in science, technology, engineering and math (STEM) fields (e.g., Cassell & Jenkins, 1998; Hayes, 2008), which are areas that are largely underrepresented by women and minorities. Kafai and Peppler (2011) point out that while research shows that online communities can provide abundant and complex learning opportunities, effective participation in large-scale groups is largely unknown.

Following up on decades of research first published by Steele and Aronson (1995), research shows that environments play a role in shaping womens' and minorities' interest and performance in STEM educational environments and careers (Hill, Corbett & St Rose, 2010; Good, Dweck & Aronson, 2007; Inzlicht & Good, 2006). A study from the *American Association of University Women* (Hill, Corbett & St Rose, 2010) found that environments played a big role in undermining female performance and interest in STEM fields, despite their skills and expertise. According to the report, decades of stereotype threat research found that gender bias in math and science environments threatened and undermined female performance (particularly in high stress, test-taking experiences), but removal of that bias produced similar performance by females and males. In particular, research has shown that females who are moderately or highly identified with male-stereotyped domains, like math, (or, in this case, gaming) can be undermined by stereotype threat in the short term through anxiety activated by stereotypes, particularly during test taking, and in the long term, through repeated exposure, which causes them to disengage from the domain (Steele, 1997). There is similar support for stereotype threatening situations occurring in gaming/leisure spaces (Stone, Lynch, Sjomeling, & Darley, 1999). "Elite female gamers playing a complex digital shooting game such as *Counter-Strike* against almost exclusively male opponents are clearly operating in a situation of stereotype threat [because] they are not just playing the game (as all the other participants are), they are concurrently disproving a number of stereotypes about females and aggressivity, technology and willingness to challenge males" (Bertozzi, 2008, p. 483). Behm-Morawitz & Mastro (2009) showed that, after playing with hypersexualized female game characters, female self-efficacy (a variable often measured to demonstrate stereotype threat) declined in relation to video games. They also found support for implicit bias directed against females by both males and females who played with hypersexualized female characters, regardless of characters' in-game abilities. Thus, we have reason to be concerned about equity when games are considered as learning environments. Are we exacerbating gender inequities by allowing gaming culture to be only safe for some (in most cases, males)? We examine one response to this concern: female supportive gaming communities.

Supporting Equity in Play through the PMS Clan

Supportive online spaces for female players have been around as long as games have allowed for competitive online play. Cassell & Jenkins (1998) discussed the emergence female-supportive communities (termed "clans" or "guilds" in the gaming space) in the late-1990s to support female engagement in hypermasculinized competitive games, like *Quake,* where players often played against teams of all male competitors. "The 'Quake Grrls' movement gives these women, who range in age from their mid-teens to their late thirties, a chance to 'play with power,' to compete aggressively with men, and to refuse to accept traditional limitations on female accomplishments" (Cassell & Jenkins, 1998, p. 34). One of the female clans documented then was *PMS Clan* (then termed, "Psycho Man Slayers," reflecting female resistance culture of the 90s, though now coined, "Pandora's Mighty Soldiers"). Further, Taylor (2006), explored female play and experience in gaming communities and found that their pleasures were more complex than the gender binary most developers (and some researchers) had in mind, often involving exploration, competition and aggressive play, as much as social play. While many female-oriented communities were documented during the late-1990s, little is known empirically, about how their supportive structures help mete out equitable learning and collaborative opportunities for game players.

PMS Clan offers a unique glimpse into how supportive communities meet equity goals in uneven playing environments. Even though it was documented in existence before the early 2000s (most clans were less formally structured in the early years), they identify a formal debut in 2002 and credit themselves as being the "world's largest multi-platform online female gaming group" (PMS, 2011). PMS is hailed in the gaming world as the oldest and most renowned female-oriented gaming community. Instead of just focusing on one game, or one game genre on one platform, the clan has over 2,000 active members globally across multiple platforms (i.e., PCs and gaming consoles like *Xbox 360* and *Playstation 3*). In 2004, the clan expanded to include male members as part of a linked "brother" clan known as *H2O Clan*. Previously, males had to be sponsored by PMS members, but for over 5 years now, male members have been able to join H2O independently. The clans are subdivided into platforms (based on the console or PC platform the player uses), and further subdivided by divisions linked to popular games on those platforms. To be an active member of the clan, players have to participate several hours a week in sponsored practices or be involved in leadership roles. While players are able to interact and play across gender, many of the divisions are separated by sex (though there are a few co-ed divisions for games with less members).

Methods

Little is known about how we can create environments that are protective against bias and threat. This research is part of a larger study of how self-efficacy and stereotype threat vulnerability play out across gender in gaming culture generally and *PMS Clan* specifically. Our research question was: Is there a difference in gaming self-concept and gaming identification across gender in PMS versus other clans? Participants responded to a call that was widely posted on several gaming sites (including PMS) and through online and social networking sites. Most respondents came from gaming clans with similar backgrounds other than gender support (i.e., similar variety and types of games). Two hundred and fifty seven (257) self-identified gamers participated in the quantitative survey, but only 143 finished it completely (94 male, 48 female, 1 genderqueer). Based on visual inspection, we assume the attrition was due to survey length, which could take 20 minutes. We excluded an additional 39 respondents who asserted they had no clan or left it blank. Males made up the majority of participants (N=65; White=45, Non-White=20), and females made up just over a third (N=38; White=27, Non-White=11). One person identified as genderqueer and, unfortunately, for reasons of statistical power, had to be excluded. Participants were divided into White or Non-White due to low numbers across ethnicities and reasons of statistical power.

Measures

A major challenge to investigating stereotype threat involves measuring its activation in context (Picho & Brown, 2011). While it should be noted that stereotype threat *vulnerability* (a general characteristic) vs. stereotype threat activation (a situation-specific characteristic) are not the same thing, vulnerability is much more practical to measure in naturalistic settings. Arguing that stereotype threat is broader than domains and activated largely in socio-cultural context, Picho and Brown (2011) developed and validated a measure that helped to measure constructs related to stereotype threat to identify vulnerability. Our survey measures were based on their *Social Identities and Attitudes Scale* to measure constructs related to stereotype threat vulnerability. We measured Gaming Identification (derived from the scale's original measure of Math Identification), and Gaming Self-Concept (derived from Math Self-Concept). Self-concept assesses one's sense of ability in an area, which can often be threatened due to activation of stereotypes. Identification is an import variable of study because it helps to demonstrate how much someone values the domain, which can over time be compromised via negative experiences. Measures of Gaming Identification included statements such as "I value gaming"; and measures of Gaming Self-Concept included statements such as "I am good at gaming."

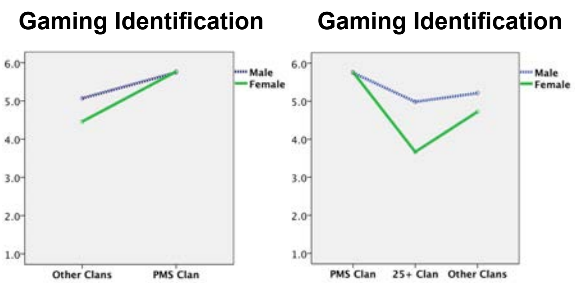
Data Analysis

In order to investigate whether there was a difference in gaming self-concept and gaming identification across gender, we first ran a 2-way between groups ANOVA to explore the impact of gender and clan status on gaming identification, and another of the same on gaming self-concept. Participants (N=103) either were in "PMS|H2O" (Males, N=33; Females, N=30), or were in a general gaming clan (Males, N=31; Females, N=8); out of those in other gaming clans, a large portion was from a clan for gamers over 25 (N=22; Males=20, Females=2) though the remainder were in a variety of other clans (N=17; Males=11, Females=6). We first ran normality statistics and removed two cases for being outliers.

For gaming identification, neither the interaction effect between gender and clan $F(1, 99) = 2.42$, p =.12, nor the main effect for gender were statistically significant, $F(1, 99)= 2.13$, p=.15. There was, however, a statistically significant main effect for clan, $F(1, 99) = 24.2$, p<.0001, with a large effect size (□^{2}□ = .196). Post-hoc comparisons using Tukey HSD show that the mean score for players, across gender, in PMS|H2O (M=5.76, SD=.75) was significantly higher than those in other clans (M=4.95, SD=1.03).

For gaming self-concept, the interaction effect between gender and clan was also not significant $F(1, 96) = .563$, $p = .46$. However, both the main effect for gender, $F(1, 96) = 6.13$, $p = .015$., and the main effect for clan, $F(1, 96) = 16.5$, $p < .0001$, were statistically significant; the effect size for gender was small ($\eta^2 = .06$), and the effect size for clan was large ($\eta^2 = .147$). The mean score for males (M=5.8, SD=.75) was statistically significantly higher than the mean score for females (M=5.6, SD=.75), and the mean score for "PMS|H2O" (M=6, SD=.62) was statistically significantly higher that that for other clans (M=5.46, SD=.84).

Because there was a large representation from members of a clan for gamers over 25, the two analyses were rerun across clan types. While power could be an issue, Levene's Test for both were not significant, suggesting homogeneity of variance assumptions were not violated. For gaming identification, the main effect for clan, $F(2, 96) = 12.5$, $p<.0001$, $\eta^2 = .206$, and now also the main effect for gender, $F(1, 96) = 4.9$, $p=.03$, $\eta^2 = .05$, were significant, though the interaction was not, $F(2, 96) = 2.25$, $p=.11$; post-hoc comparisons using Tukey HSD reveal that the mean score for gaming identification in PMS Clan (M=5.8, SD=.75) was statistically significantly higher than the clan for gamers over 25 (M=4.86, SD=1.2) and the other clans (M=5.04, SD=.88). For gaming self-concept, the main effect for clan, $F(2, 94) = 8.22$, $p=.001$, $\eta^2 = .149$, and the main effect for gender, $F(1, 94) = 5.54$, $p=.021$, $\eta^2 = .056$, were significant, though the interaction was not, $F(2, 94) = .57$, $p=.57$; post-hoc comparisons using Tukey HSD show that the mean score for gaming self-concept in PMS Clan (M=5.98, SD=.62) was statistically significantly higher than the clan for gamers over 25 (M=5.5, SD=.92) and the other clans (M=5.3, SD=.75).



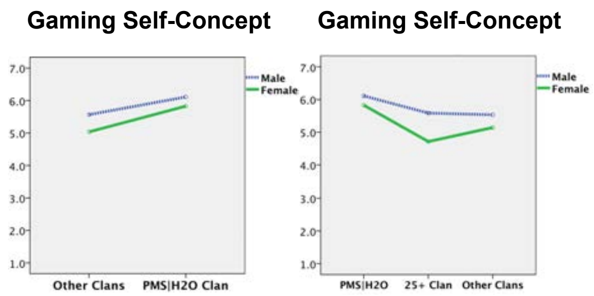


Figure 2 (left): Gaming Identification by Clan and Gender. Figure 3 (right): Gaming Self-Concept by Clan and Gender.

Discussion, Limitations and Future Directions

We did find statistically significant differences that favored males over females, and members of "PMS|H2O" over members of other clans when it came to gaming self-concept, or our measure of perceived ability. However, while we are seeing gender differences, they account for a smaller part of the variance, and clan membership seems to have a significant relationship with confidence and positive self-appraisal of ability. While fully understanding what is happening involves further exploring contextual factors, it is telling that such a significant difference in perceived ability exists between gaming communities. Also, finding that females who are in clans are more likely to have significant differences in perceived abilities is telling of a possible story where community interactions or structures that are not supportive in specific ways may be having a strong effect. We would need to follow-up with more detailed exploration of the kinds of in-community experiences players are having, across gender, and across communities that are and are not explicitly supportive, as well as what kinds of behavior might be elicited as a result.

As discussed earlier, gaming identification is a measure of how much an individual closely values and feels connected to gaming. For the most part, we are finding that gamers in our sample feel equally connected to gaming, regardless of gender. In other words, we are not seeing evidence of social distancing from the domain across gender (at least not yet). As the literature shows, distancing from a domain or area where you feel you are stereotyped to underachieve is something that usually happens over time with multiple threatening situations. It could be that gaming may not be vulnerable to the same kinds of social distancing as academic environments might be, or another, more plausible, scenario is that people may either distance themselves from gaming altogether (in which case they would not occur in our sample), or may distance themselves from more threatening situations in gaming instead of gaming as a whole. For example, a player may choose to avoid a competitive game type known for more aggressive language and behavior, or, conversely, players could hide their gender or mute themselves or others to avoid the more negative experiences, and still feel closely connected to gaming in general. In order to get to more of the complexity around identification with gaming, we would have to follow-up with more in-depth analysis of what kinds of games these players are playing, and whether and how those experiences vary by game type and gender or something else, like age, ethnicity, or personality.

However, we did find significant differences between "PMS|H2O" clan members and members of other clans when it came to gaming identification, with vastly different mean scores and a large amount of the variance explained by clan membership. In other words, gamers in the gender-supportive clan are either more likely to be highly identified with gaming at onset or develop greater identification with gaming over time in the clan compared to those in other clans. While it is hard to say exactly what is happening, the large contextual differences speak to a larger story about how communities can have an effect on the investment and connectedness someone has with a domain. Since we are still learning about the effects of gaming community quality on learning, the fact that there is such a difference is important. As Picho and Stephens (2012) point out, gender supportive environments, particularly single sex schools, have been important in shaping equal identification and sense of perceived ability, particularly for females, in areas they are stereotyped to underachieve because the social environments encourage equity while providing female roles models in underrepresented areas.

However, measuring individual differences by gender alone may not be the best course of action. For example, newer research is showing what we thought were gender differences in game preferences has more to do with access, support and experience (e.g., Vermeulen, Van Looy, De Grove & Courtois, 2011). In these cases, environments that offer differential access, support and encouragement are more of the barrier than gender. Since the participants in this sample are closely connected to gaming already, across gender, the more salient matter may be a situation where bias or threat is introduced. This is where the differences between gaming environments is important. In the gender supportive clan, we are seeing that males appear to be equally gravitating to or receiving support from its structure as females. Since the clan's central mission revolves around supporting female play, it is particularly compelling to understand why and how that mission affects male gaming experience. In addition to being explicitly structured so that females have safe, private spaces in the clan (including all female divisions and forums), the clan has strict rules around harassment and fair play, including rules that prohibit general negative behavior, such as cheating, bullying and the like (PMS, 2012); in an effort to make things more equal and sportsmanlike in general, they may actually be creating a more universally appealing game environment and community through striving for equity.

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Two-Way Play: Early Research Findings of Learning with Kinect Sesame Street TV

Meagan Rothschild, University of Wisconsin-Madison, mrothschild@wisc.edu

Abstract: Microsoft Studios has recently released *Kinect Sesame Street* TV, a new form of media for television that merges traditional means of watching episodes with game like physical actions via the Xbox and Kinect. This paper presents an overview and early findings of an initial study that investigated how ideas of embodied cognition and comprehension can be leveraged to understand the experiences of three and four year old participants, and explore the ways in which bidirectional television can facilitate new meaning-making. Early research took place at Microsoft Research in Redmond, WA, and analysis is continuing at [removed for blind review]. The findings inform the development and design of other interactive television products and programs for early learners. The presentation also breaks down directions for future analysis, showing how initial findings illustrated a need for deeper research and analysis in the nuanced ways young children learn and demonstrate knowledge.

Introduction

A narrative experience is more than a “played story”. It’s the series of ways that engagement play out that is personalized, and contextualized. It may include a story, a series of mechanics, activities, and practices. The narrative worlds we engage in influence the creation of our own live narratives. And through engagement in these practices, relevant skills can become developed. One of the most common entry points for mediated narratives in the lives of children is through television programming. The role of television experienced a revolution in the 1970s through the production and growth of Sesame Street. In the 1990s, shows like Dora the Explorer and Blues Clues expanded the role of educational television and active participation, shifting again the way we think about educational viewing. Now we are on the cusp of a new paradigm shift for television and learning, with motion enabled peripheral devices like the Xbox Kinect actually *enabling* active participation, and viewers engaging with a responsive system, rather than a scripted vehicle with flat user-feedback. One platform coming out of Microsoft’s playful learning initiatives is two-way television, a means of combining entertainment with learning experiences by engaging physical activity and embodied learning practices. In Fall 2012, Microsoft Studios released *Kinect Sesame Street TV* and *Kinect National Geographic TV*, both of which utilize the Kinect motion capture system to allow episode viewers to engage with the show differently than if they were participating in a traditional television show.

Designers of *Kinect Sesame Street TV* worked to extend an already successful media legacy. The traditional Sesame Street television format has been shown to produce learning gains in younger viewers over the last forty years, including a longitudinal study that further supported these findings (Ball & Bogatz, 1970; Bogatz & Ball, 1971, Fisch & Truglio, 1991). The designers at Microsoft needed to make sure that the added Kinect interactivity wouldn’t break the potential for learning gains found in the linear television format (Fisch & Truglio, 2001). Microsoft’s design goals included the incorporation of research on learning and media use. First, according to situated learning theory, people learn content better when it is in the context of relevant activity. Therefore, the activity of the Kinect episodes must be tightly connected to the learning content (A. Games, personal communication, October 10, 2012). Secondly, viewing learning through a lens of embodied cognition highlights that a core way to learn a concept is by connecting that concept to one’s own perceptions, which includes relationships between the content and themselves/their own bodies. Kinect needed to allow participants to take on the specific actions that physically connect them to content (Glenberg, Goldberg, Zhu, 2011; Barsalou, 2008). Next, the entry threshold must be very low, making it simple for a variety of participants at different ability levels to enter the playful learning space. Finally, designers wanted to transform television into a deeper diologic experience by embedding performative assessment within the episodes. The goal was to allow the environment to absorb the negative connotations of feedback, and playfully encourage participants to go further in their experiences (A. Games, personal communication, October 10, 2012). The result of this design process was the version of *Kinect Sesame Street TV* released in the fall of 2012. While playtests during the iterative design cycles helped fine tune interactions and navigation, questions still remain regarding the impact of this new medum on meaning-making for children in the target audience.

The emergence of a new media format that blends traditional elements of television viewing with game-like activities for learning leads researchers to ask how ideas of embodied cognition and comprehension can be investigated in bidirectional television products in order to understand the experiences of participants, explore the ways in which the products facilitate meaning-making, and utilize findings to support design of future interactive products. This study began to investigate these questions by studying the experiences of young children who participated with a single *Kinect Sesame Street TV* episode. Existing research provided a foundation for the new line of educational research.

Assumptions:

1. The Sesame Street TV model results in increased comprehension, particularly with content emphasized most heavily (Ball & Bogatz, 1970; Bogatz & Ball, 1971, Fisch & Truglio, 1991).

2. There are short and long term benefits of educational programming on both specific knowledge and general skills, including school readiness (Fisch, 2004).

3. Repeated viewing increases comprehension (Crawley, Anderson, Wilder, Williams, & Santomero, 1999).

4. Visual attention is linked to cognitive processing. Children attend to things they're thinking about, such as cognitively demanding tasks, or content that is meaningful (Anderson, Lorch, Field, & Sanders, 1981).

5. Activity influences the way meanings are constructed (Barsalou, Niedenthal, Barbey, & Ruppert, 2003; Glenberg, Jaworski, Rischal, & Levin, 2007; Glenberg, Brown, & Leven, 2007).

Based on these premises, the following research questions guided the inquiry, methods, and data analysis. (See Figure 1 for a visual representation of the study flow.)

1. What does engagement in Sesame Street Kinect TV look like for 3-year old participants? (Keyword: ***VIEWING***)

2. How do participants demonstrate engagement when utilizing interactive features of Sesame Kinect TV? How do participants not using interactive features of Sesame Kinect TV demonstrate engagement? (Keyword: ***INTERACTION***)

3. What concepts are participants of interactive and traditional Sesame Kinect TV episodes learning? (Keyword: ***COMPREHENSION***)

4. How does repeat participation impact interaction and comprehension? Does this differ between interactive and traditional users? (Keyword: ***REPLAY***)

Analysis with the data set from this preliminary study will be comprehensive and ongoing. This report covers early outcomes from the study, however it should be noted that deeper quantitative and qualitative analysis will continue to take place, and findings may become deeper and more highly contextualized. The first phase of analysis included descriptive statistics of the participant, an early analysis of pre/mid/posttests, and a review of observation notes for themes and presenting variables that need deeper analysis.

Method

A group of forty-two 3 and 4 year-olds participated in the study. The group contained a mix of girls and boys from across the Seattle area. Participant families were required have regular access to an Xbox 360 and Kinect in the home, have never viewed *Kinect Sesame Street TV* episodes, and be proficient in the English language. Data was predominantly collected at the Microsoft User Research Labs, and consisted of video footage, observation notes, pretests and posttests, and parent surveys (including demographic data). Participants were divided into two groups of twenty by a process of stratified random sampling, accounting for gender and known family annual income. One group of participants was designated as the *KINECT* group, in which Sesame Kinect TV experiences took place as designed, with all interactions ON. The other group was the *TRADITIONAL* group, in which all interactions in the episode were turned OFF, and the participant experienced the same content like a standard TV show (See Figure 1 on next page for a study diagram).

The study began at the Microsoft Studios User Research Lab. All participants were accompanied by a parent or guardian, and took part in a pretest prior to the viewing of the episode in the lab. Pretests covered key content presented in the selected episode. Participants then watched the episode. Parents or guardians in the room with the child were encouraged to engage with their children during the episode in any way that felt natural or comfortable for them. The guardian also completed the demographic and media use survey at that time. All assessment and play was audio/video recorded. Following the viewing, participants completed a midtest that matched the pretest (with the exception of switching from predictive story telling to a retell based on image prompts).

The next phase of the study was the independent viewing of the episode. Following the first viewing in the research lab, parents/caregivers were given a disc with the same episode viewed in the lab (*KINECT* or *TRADITIONAL*) for use on their home Xbox/Kinect. Parents were encouraged to allow the child to watch the episode at least 3 more times, and were asked to record when and how much of the episode was watched each time. They were also given the option of providing observational feedback, which many parents took advantage of.

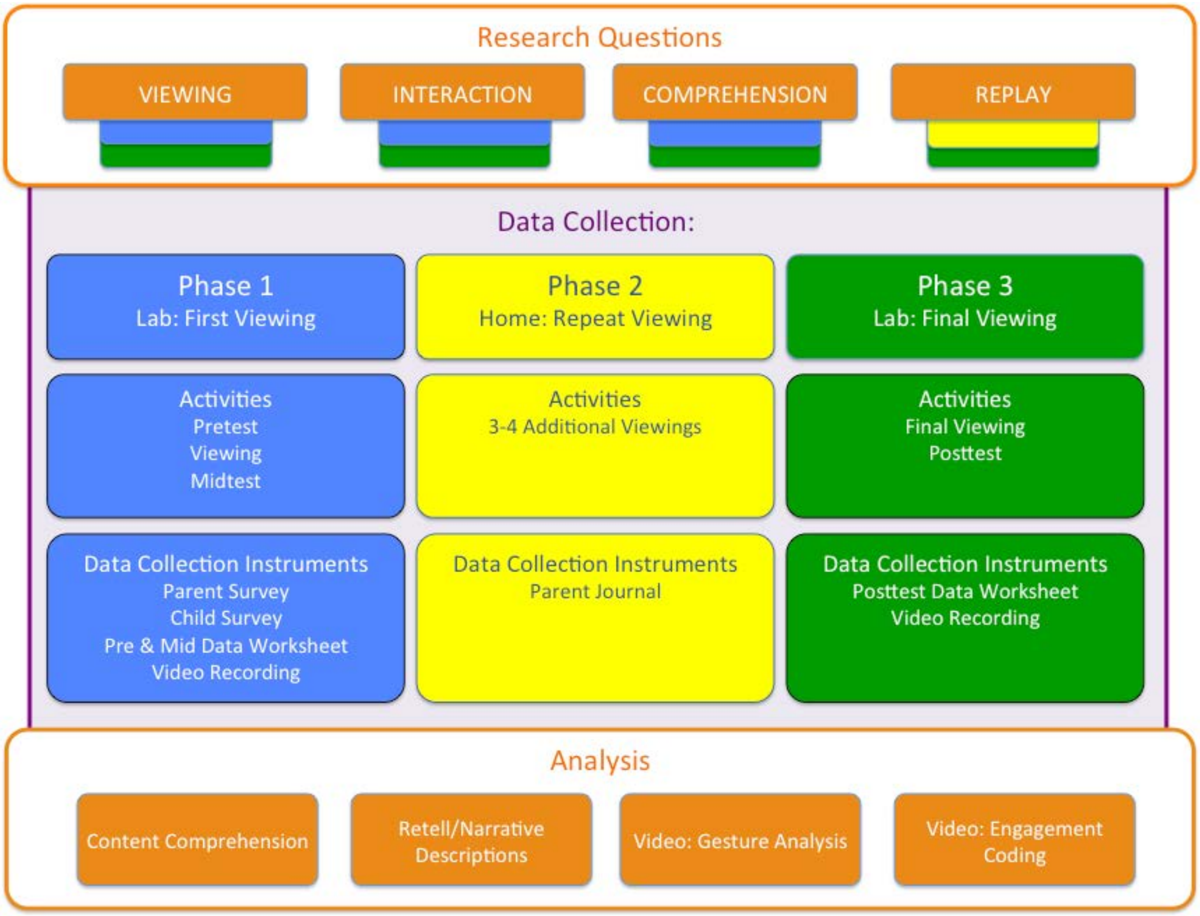

Figure 1: Visual diagram of Kinect Sesame Street TV Study.

The final phase brought participants back for a replay of the episode and post test. Participants returned to the lab approximately two weeks after their first visit. A replay of the same version of the Kinect Sesame TV episode was presented based on their status as *TRADITIONAL* or *KINECT* participants. Play was again be audio/video recorded, and parents/caregivers in the room were encouraged to engage as was natural and comfortable. All participants will took part in the same post-test immediately following their final in-lab play time, which matched the midtest.

Learning Objectives and Assessment Measures

The learning objectives assessed were culled from a content analysis of the episode selected (see Table 1 on the next page for a breakdown of assessment activities). The episode content was analyzed for core content frequency, and content tied to interactivity. The primary content identified as most targeted/emphasized in the episode were identified as core learning objectives that were assessed in the pretest, midtest, and posttest. Questions were supported with images for cued recall whenever appropriate. Questions also included performance-based activities, such as working with manipulatables, retelling, action-based content applications, etc., in order to maintain an “active participation” measure, linking to the elicited behaviors from the episode. Performance-based activities utilized non-digital manipulatables, so assessment activities in the pretest included a modeling compenent in an attempt to reduce potential confounds from switching activity modalities from digital to analog.

Content	Assessment Activity
Letter "H" Recognition	Identifying the letter "H" in a paper-based letter "H" show. Targeted response – clap for the letter H, don't clap for other letters.
Vocabulary – Relational Concepts (Over, Across, Between)	Scene is created with manipulatable objects (hills, pond, Cooper puppet, Cooper's camera). Child must navigate Cooper to the camera using the targeted relational concept.
Counting and Enumeration – 5	Child is tasked with counting five apples and putting them in Cookie Monster's bucket.
Street Story Retell	Child is shown three key images from the street story "Failure to Launch" and is asked to retell what happened in the story.
Word understanding: "measure"	Prompted w/ image of Baby Bear and ruler, asked what it means to measure something.
Word understanding: "launch"	Prompted with images from street story, and given recap sentence that *Hubert the Human Cannon Ball needs to LAUNCH from the cannon to the bucket of blue gelatin that is precisely five feet away*. Child is asked what "launch" means.
STEM value: Curiosity & Wondering	Prompted with an image of Ernie singing his song about wondering. Child is asked if they get curious abou things or if they wonder about things. (This question my be fairly abstract, but is left as an open question to see what kind of concepts the child attributes to the song. Is not evaluated for correctness/incorrectness.)
Open-ended feedback on episode experiences.	Child is prompted with key images from each segment of the episode. Child will be asked which were favorite parts, least favorite parts, what kinds of activities he/she did, etc.

Table 1: Assessment topics of Kinect Sesame Street TV pilot study.

Discussion of Findings

The study included a total of nineteen males and twenty-three females, all between the ages of 3 years old, and four years and eleven months old. Because recruitment for a group of that size that met the criteria for participation was a challenge, the study was opened up to employees of Microsoft and partner contract companies. In the study population, seventeen children were from families external to Microsoft, and twenty-five were from Microsoft/MS contractor families. The range of annual income was between $0-15,000 and $150,000+. The *KINECT* and *TRADITIONAL* groups were broken down evenly, with 21 children beginning in each group. The attrition between first and second visits to Microsoft was two participants; so twenty children from each group completed the viewings.

Early Analysis of Pre and Posttests

Early comprehension analysis included responses from the letter H game (four items), the relational concept manipulation activities (three items), and knowledge of the number five (two items) for a total of nine items. Preliminary analysis shows that there is a statistically significant increase for both *TRADITIONAL* and *KINECT* groups in the pre to mid to post assessments (See Figure 2 on the next page for a diagram of assessment gains). There is not a statistically significant difference between the two groups, nor is there a statistically significant difference between gender. These are preliminary findings, and require further investigation to consider possible influences of additional variables in player comprehension results.

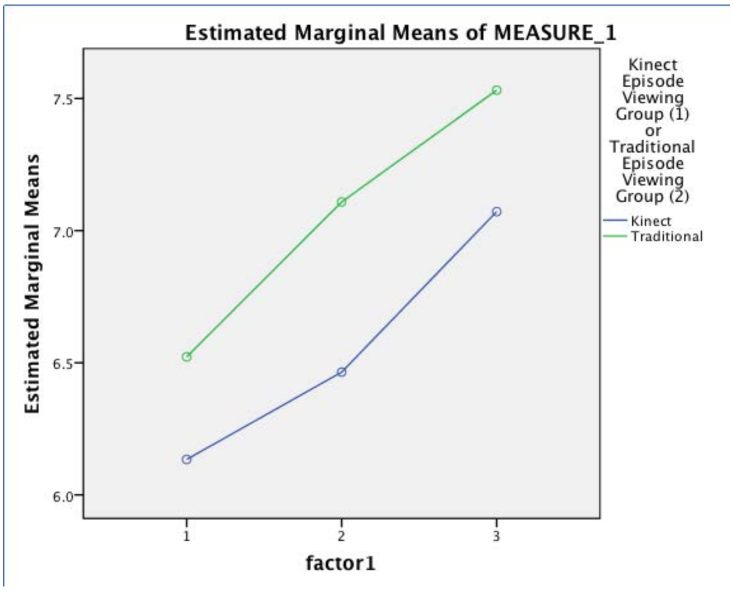

Figure 2. Estimated marginal means of KINECT and TRADITIONAL groups from pre (1) to mid (2) to post (3) test.

Emerging Themes and Areas For Deeper Analysis

Initial evaluation and notes from the viewing sessions illustrate emerging themes that require deeper evaluation. While early analysis of the comprehension data shows no significant difference between the *KINECT* and *TRADITIONAL* viewings and that both groups increased in targeted concept knowledge significantly, other observations indicate a difference in the ways participants engage with the program. For example, the *TRADITIONAL* viewers had more instances of kids watching from the floor on their tummy (lying down), and engaging physically with the prompts with less energy/movement size than those in the *KINECT* version. Also, less interactive episode segments seem to have higher rates of distractibility. The experiences of the participants are greatly nuanced, and require an analysis across multiple dimensions of viewing experience before broader and more declarative statements can be made.

One specific example is the need for deeper gesture analysis of the way participants demonstrated knowledge of the relational concept “between”. Things were initially coded with a correct/incorrect (1/0), however, the coding does not take into account the variety of ways children demonstrate their concept awareness. The assessment for the concepts took place in an activity that was designed to feel game-like. The researcher placed two green bowls upside down on the floor to represent hills or mountains, and placed a flat cutout of a lake near the middle of the two hills/mountains. A figure of Cooper Monster, one of the characters in the episode, was placed on the far side of one hill/mountain, and a figure of a camera was placed on the opposite side (See Figure 3, below).

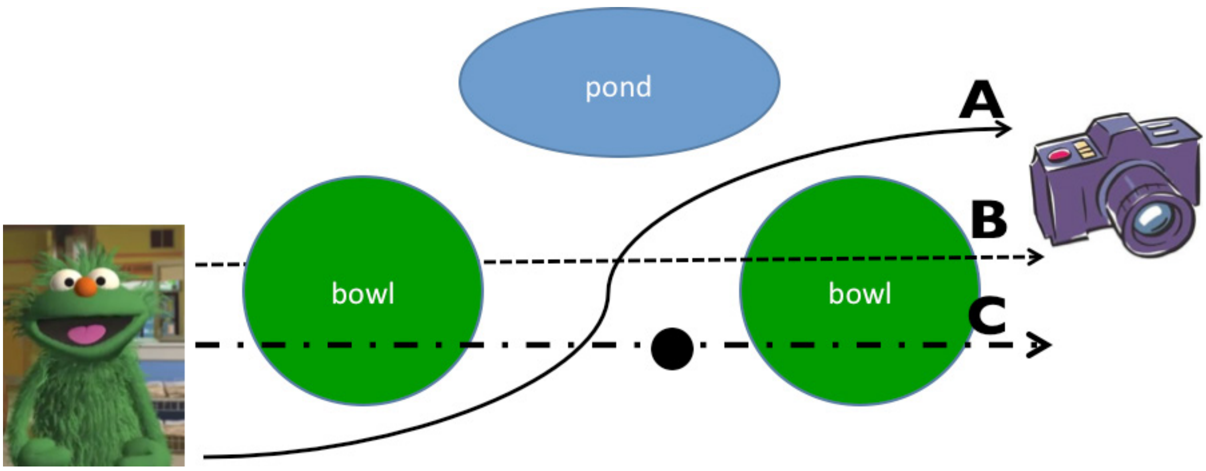

Figure 3. Demonstrations of the relational concept “between”.

In the relational concept assessment, children were told that Cooper lost his friend Flash (the camera), and that they were going to play a game to help Cooper find him. The researcher would flip a card with the relational concept (between, across, and over), and prompt the child to go between the mountains/hills, across the lake, or over the mountains/hills. Demonstration for "over" and "across" remained fairly straightforward. However, for the concept "between", participants demonstrated it in a number of ways. The most seemingly logical response to "Help Cooper find Flash by going between the two mountains" would be to follow path A in the figure above. However, some children moved Cooper over the mountains with a solid landing in between the two (path C). Yet a couple others picked up the first bowl and slid Cooper between the bowl and the floor before continuing him on to Flash (path B). Still another child tried to push Cooper into the side of the bowl, as if wanting the bowl to split into two parts so Cooper could move between them (not pictured in Figure 3). Deconstruction of the ways children are demonstrating knowledge of the relational concept "between" will at the least require a new coding scheme and deeper gesture analysis.

Another example of the need for deeper gesture analysis of video data emerged with the way one participant showed her knowledge of the meaning of "measure". In the pretest, she was asked what Baby Bear was doing in an image with him holding a ruler. She responded that he was measuring. When asked what a person is trying to find out when they measure something, she responded "how tall." In the episode, she watched Baby Bear measure the distance that Hubert the Human Cannon Ball flew across Sesame Street. After watching the episode the researcher engaged her in the same line of questioning. She responded again with "how tall", except this time, she held her hands out to indicate a horizontal distance. This shows that she is changing how she demonstrates her concept knowledge to align with the way it is framed in the episode.

More analysis will also take place with questions regarding gender. Early observations indicate that there may be differences in the ways girls demonstrate connections with narrative elements, as compared to participant boys. Finding the more nuanced differences will require an analysis of the coded engagement data that is weighed against the results of the discourse and gesture analysis.

Plans for Future Quantitative and Qualitative Analysis

The next phases in analysis includes detailed coding of participants' open-ended answers. Coding will utilize apriori schemes, and may be adapted as patterns emerge. Engagement measures will be coded for every minute and a half of episode and will follow a Sesame Street engagement metric that has been modified for the Kinect activity and specific study. This includes noting weather the child has eyes on screen (EOS) or if they are not watching (NW). Specific behaviors will be noted, including whether a child is sitting, standing, or lying down; different types of expressive pleasure such as laughing, smiling, or clapping; responses to cues and prompts; unprompted actions or imitations; labeling, classifying, or predicting based on the actions on screen; and comments, judgements, or life connections in response to on-screen activity.

In addition, discourse and gesture analysis will take place on the open ended responses, as early observations indicate that the depth of answers that take place between first and second viewing may illustrate how participants express movement from shallower content knowledge to deeper and more situated understandings, that they then demonstrate through both discourse and gesture. More extensive findings from qualitative analysis will be presented for this presentation at the time of the conference.

Conclusion

We live in world where our experiences are increasingly technologically mediated. And these experiences can serve as the catalysts for experimentation, play, discovery, creation, and meaning-making. This means different things for different kinds of development. Childhood learning and development is a highly nuanced progression of experiences. The way they learn, know, and show is more complicated than "less learned grownups", their processes of learning and experiences are complex, and deeply embedded in individual experiences and development trajectories. Their meaning making processes are highly socialized. Their play spaces and narrative interaction push boundaries of meaning. Meanings and identities get experimented with and worked out in play spaces. It's an important place for children.

For both designers and researchers, we need to not only understand, but *respect* the complexities and nuances in our work. More research is needed to understand how physically interactive experiences like bidirectional television can be a tool for moving content from mediated experience to discourse and application. This research has been an exploratory pilot to begin to identify themes and connections between bidirectional television viewing and meaning-making, and this analysis an early first pass of the data corpus the pilot provided. The results from this study can be used to develop broader studies that include a larger participant base, multiple episodes, a more targeted series of research questions, and even may include additional bidirectional properties. In addition, the outcomes from this and future studies can continue to inform design, from specific recommendations on interactions to broader design for learning questions, such as how activities can move a participant towards meaning and pleasure, how activities and practices empower the participant to make larger connections beyond the product, and given what we know and are continuing to learn about the ways children engage with their mediated narrative experiences, how products can serve as a catalyst for deeper engagement and creative expression.

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Counting Coconuts and Apples: Young Children 'Kinect-ing' *Sesame Street* and Mathematics

Meagan Rothschild, Caroline C. Williams, Jordan T. Thevenow-Harrison
University of Wisconsin - Madison
meagan.rothschild@gmail.com, caro.williams@gmail.com, jtth@jtth.net

Abstract: The ability to count objects is a crucial skill for young children. We report on an experimental study that utilized a *Kinect Sesame Street TV* intervention designed to support two types of counting activities. Our quantitative analysis is supplemented by our preliminary qualitative analyses, and the complexity of these contexts for mathematical learning is unpacked with the assistance of literature from the fields of mathematics education and cognitive science. We conclude by making recommendations for interactive educational design in general.

Introduction

A foundational skill that young children need to develop for mathematics learning is counting. The Common Core State Standards for Mathematics Kindergarten standards state that students should learn the number names and count sequence, and be able to count objects (National Governors Association Center for Best Practices, 2010). The National Council of Teachers of Mathematics include in the pre-kindergarten to second grade-band the requirement that all students learn to count with understanding, be able to determine the size of sets of objects, and use numbers to count quantities (2000). Being able to count and connect the counting specifically to specific objects is a crucial part of learning to mathematize the world, as well as continue in further mathematics learning trajectories. This project focuses specifically on supporting 3 and 4 year-old children in counting by using a *Sesame Street* episode made interactive by the Microsoft Kinect. In the following section, we review literature on videogames and learning, and embodied cognition and mathematics. We then further describe the relationship between the Kinect and *Sesame Street*, before transitioning to Methods.

Considerably varied research indicates that videogames can be powerful vessels for learning (Barab, Gresalfi, & Ingram-Goble, 2010; Fisch, Lesh, Motoki, Crespo, & Melfi, 2011; Gee, 2003; Squire, 2011; Steinkuehler & Duncan, 2008). By leveraging some elements of videogame design and making the traditionally televised one-way information flow into an interactive learning experience, the *Sesame Street* Kinect series has the potential to increase the engagement and learning of its participants. In particular, this multimodal design aligns with embodied cognition research that suggests that cognition and action are intertwined (Shapiro, 2011). Theories of embodied cognition contend that thinking and learning are not based on amodal symbol systems, but rather are inextricably woven into action and perception systems (Barsalou, 1999, 2008). Researchers examining the relationship of action and gesture to mathematics learning have found promising results (Alibali & Goldin-Meadow, 1993; Glenberg, Jaworski, Rischal, & Levin, 2007; Nathan, Kintsch, & Young, 1992), including interventions in which actions and gestures are designed to be related to successful solving of specific conjectures (Dogan, Williams, Walkington, & Nathan, accepted; Walkington et al., accepted; Walkington, Srisurichan, Nathan, Williams, & Alibali, 2012). In summary, physical action can influence mathematical cognition, and consequently, using the Kinect in conjunction with episodes designed to support mathematical learning may leverage action as a way to support cognition.

In 2010 Microsoft Studios released the Kinect, an Xbox peripheral device for motion-sensing input. Since it's release, Microsoft has worked on ways to engage audiences beyond their traditional core gamer, producing titles like *Dance Central*, *Kinect Sports*, *Disneyland Adventures*, and *Nike+ Kinect Training* to engage kids and families. Among the products that Microsoft has released to push the boundaries of a traditional gaming and the television viewing experience is Kinect TV (2012), with initial product lines that include a uniquely developed set of *Sesame Street* interactive television episodes.

Sesame Street is a proven television format with an extended media legacy of success. The format has been shown to produce learning gains in younger viewers across studies over the last forty years, including a longitudinal study that supports the findings of learning gains (Ball & Bogatz, 1970; Bogatz & Ball, 1971, Fisch & Truglio, 1991). For the developers of *Kinect Sesame Street TV*, the goal was to extend an already successful media. The designers wanted to design from a firm research base to make sure that the added Kinect interactivity wouldn't break the potential for learning gains found in the linear television format (Rothschild, internal Microsoft white paper, 2012). This included understanding situated learning theory and the role of learning in the context of relevant activity (Gee, 2003; Barsalou, Niedenthal, Barbey, & Ruppert, 2003), and viewing the potential learning through a lens of embodied cognition, connecting concepts to a learner's own perceptions which includes relationships between the content and themselves/their own bodies (Glenberg, Jaworski, Rischal, & Levin, 2007; Glenberg, Brown, & Leven, 2007).

The questions about the nature of learning with *Kinect Sesame Street TV* led to a research project conducted at Microsoft Studios in which researchers began to investigate the nature of participant experiences in two-way episodes and traditional builds, what concepts are learned in each context, and how interactivity may relate to concept learning. The episode follows *Sesame Street*'s emphasis on literacy and STEM, and includes a word of the day, a number of the day, and to connect to the interactive elements, a move of the day. The preliminary results show that all students that watched the episode in this study (both experimental and comparison groups) showed statistically significant learning gains when all the tests were collapsed. This paper goes deeper into a quantitative analysis of the questions specifically related to number knowledge, and presents the preliminary investigation of the number knowledge component of the episode studied within the frames of current math education and cognition research.

Methods

Forty-two three and four year-olds participated in the study. The group was composed of a mix of boys and girls from Seattle and its surrounding areas. The requirements for participant families were that they needed to have regular access to an Xbox 360 and Kinect in their home, that they had not previously viewed the episodes, and that the child was proficient with English. Data was predominantly collected at the Microsoft User Research Labs, and consisted of video footage, observation notes, pretests and posttests, and parent surveys (including demographic data). Participants were divided into two groups of twenty-one by a process of stratified random sampling, accounting for gender and known family annual income. One group of participants was designated as the *KINECT* group, in which *Kinect Sesame Street TV* experiences took place as designed with all interactions on. The other group was the *TRADITIONAL* group, in which all interactions in the episode were turned off and the participant experienced the same content as was in the episode, edited to a non-interactive, linear format.

Participants came in to the research lab with a parent or guardian, and participated in a pretest, watched the episode, then completed a midtest. The child and guardian left the lab with a copy of the episode in the format that they viewed (*KINECT* or *TRADITIONAL*) and then played the same episode at home over the next couple weeks. Parents logged their child's play and made observations. The child and a parent or guardian returned to the lab one more time to view the episode and then participate in a posttest. For the purposes of this paper, analysis is specifically targeting the questions regarding the number five (the number of the day for the episode), and comparing pre- and posttest scores for analysis.

Number Knowledge in the Episode

In the episode, the scene opens with Cookie Monster dropping a banana peel on the ground, which a bustling Grover then slips on, dropping his delivery of five coconuts. Grover then asks the audience member to please help him collect his five coconuts by throwing them into his box. For each throw, an image of the box is displayed with a visual of how many coconuts are now in the box. The number of coconuts in the box is displayed in the lower right corner of the box (See Figure 1 on the next page). Grover states, "Now I have *(number)* coconuts in the box." At the end, the box with five coconuts and the number five in the bottom right corner is displayed as Grover cheers, "Hooray! Now I have FIVE coconuts!" In the *KINECT* group, when the participants threw, the Kinect motion sensor would respond to their movement in the system, and the coconut would fly into the screen and into Grover's box, sometimes in silly and surprising ways (See Figure 2 on the next page). If the child did not throw the coconut, Cookie Monster would come into the scene having "found" one, and drop it into Grover's box. Grover would then ask the audience member to try throwing the next one. The *TRADITIONAL* group would get the verbal prompts from Grover to throw the coconut, however, their activity did not affect the way the show progressed, and for each coconut, the show would progress as if the child had made a successful throw.

Figure 1: Throwing coconuts into Grover's box.

Figure 2: Participant throwing coconut.

The Performance Assessment

The assessment activities were designed to feel playful and both match the spirit of the episode and align with the sorts of performance elicited in the show. The researcher began by asking the participant to pretend with her, pretending that they had been walking through an apple farm together (situating the activity). The researcher then declares, "Oh look! We found some apples on the ground!" and displays a page with five apples on it (See Figure 3 below). The researcher then asks, "Can you count how many apples we found?" and prompts with "Point to and count each apple that you see" if necessary. If the child counted to five, it was coded as correct; anything other than counting exactly to five was coded as incorrect.

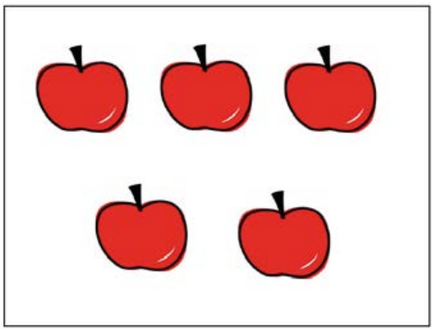

Figure 3: Enumeration activity.

Immediately following the enumeration activity, the researcher segued into the number application activity by telling the child that Cookie Monster loves apples, and that today they were going to help him cook! The participant helped decide what should be cooked (apple cookies, apple cake, applesauce, etc.), and the researcher brought out a bowl, seven foamcore apples, and an image of Cookie Monster, placing them in front of the child (see Figure 4 on the next page).

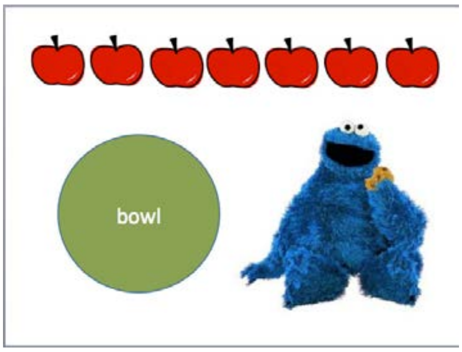

Figure 4: Number application activity.

The researcher then told the participant that Cookie Monster needed exactly five apples to make his recipe, and asked, “Can you put five apples in Cookie Monster’s bowl?” If the participant placed five apples in the bowl, it was coded as correct. Anything other than five apples in the bowl was coded as incorrect.

Results

In this section, we share the results we anticipated, and then share the actual results. We then explore more deeply why some of our expected results and actual results did not align, and propose an explanation of this divergence. We then make recommendations to field as a whole, in order to give insight into designs that more deeply support the desired types of learning.

Expected Results

As a consequence of playing the *Sesame Street* episode, we expected the children to improve in their ability to count to five, and to increase their understanding of how an individual object relates to a set of objects. In particular, we expected children to know that if—for example—one apple had already been counted, adding another apple would result in two apples total, and so on until five apples were reached. Based on the existing success of the *Sesame Street* platform and the earlier preliminary results of the overall assessment (Rothschild, internal Microsoft white paper, 2012), we theorized that both groups would show learning gains, with the possibility of the *KINECT* group showing greater gain due to increased activity and engagement.

Actual Results

The actual results did not unilaterally fulfill our expectations. Regarding our hypothesis that the *KINECT* group would perform better than the *TRADITIONAL* group, no significant difference was found between the two conditions according to Fisher’s Exact Test for the enumeration ($p > .05$) or the number application ($p > .05$) tasks. Furthermore, no significant difference was found when the conditions were collapsed ($p > .05$). However, the results of our preliminary qualitative analyses align quite well with literature on child development and mathematics learning, and suggest that the lack of significance is due to considerably different reasons for each test.

For the enumeration test, 38 children contributed complete data to our analysis. Of those 38 children, 28 were successful in enumerating five apples during the pre-test, indicating that counting to five was a skill that these participants were already quite competent at. At post-test, 32 participants were successful (which included all 28 who replied accurately during the pre-test). Given that nearly 75% of participants came into the study with the target skill, it is hardly unexpected that a ceiling effect occurred.

The number application test, on the other hand, suffered from no ceiling effect but similarly demonstrated few gains. 16 of the 38 participants were successful during the pre-test, and only 20 were successful during the post-test (again, all the participants who performed correctly during the pre-test continued to be correct in their post-test). Intriguingly, as an exact but nonverbal task, this performance assessment appears to be quite achievable, even for participants of this age (e.g., Baroody, Lai, & Mix), so the study did not accidentally include a task with achievable content but overly challenging performance demands (as Gelman & Meck (1983) so eloquently warn us about).

Reconciliation of Expectations and Findings

The results of the number application test were surprising and interesting. Our preliminary qualitative analysis indicates a nuanced complication: participants who enumerated five apples and *then* placed them simultaneously into the bowl were likely to be successful. However, participants who attempted to enumerate the apples one-by-one, placing each one into the bowl individually, were likely to be unsuccessful. Starkey (1992) offers illumination into this quandary (following the path of Gelman & Gellistel, 1978), by distinguishing between *numerical abstraction* and *numerical reasoning*:

> Numerical abstraction (or enumeration) comprises a set of abilities that are used to form representations of numerosities of sets. An example is verbal counting. Numerical reasoning comprises a set of abilities that are used to operate upon or mentally manipulate representations of numerosity. (p. 94)

Consequently, our preliminary results indicate that participants who used an enumeration strategy during this task tended to be successful, while other participants were unsuccessfully attempting to mentally represent both the desired set size (five) and the current set size (how many apples were already in the bowl, and not easily visually accessible). Young children tend to be successful at counting when they can move and touch the objects they are counting, and considerably less successful when they cannot do so and must consequently maintain a mental representation of the set in their minds (Gelman & Meck, 1983), as well as perform the numerical reasoning necessary to continue adding objects to the set.

Recommendations for Interactive Educational Design

Our design recommendations are broad, and go beyond the scope of this particular study. It is quite easy to examine the findings of the second performance assessment and make particular design recommendations. For example, based on the literature cited above, the finding that participants struggled to count five apples into the bowl is not surprising—and fixing it may be as simple as re-designing the intervention so that Grover responds slightly differently when catching a coconut. For example, when the third coconut lands, Grover could say, “Three! One, two, three!” (while pointing at the individual coconuts). This design may support the children in not only counting but in repeatedly being exposed to the relationship of one object to the full group of objects. Naturally, this recommendation needs empirical testing! Consequently, we go beyond this local recommendation and instead venture to make some recommendations for the field as a whole.

The interactive media industry is saturated with products and applications targeting basic math and literacy skills for early childhood. A strong conceptual foundation requires that children have the ability to move from basic knowledge to content application. This analysis shows that for an older preschool target audience, interactive media developers would be well advised to move beyond enumeration activities and look into supporting the transition from enumeration to number application. Additionally, this analysis shows that what may appear (particularly to adults) to be a simple cognitive progression may be riddled with complexities for a young child who is learning higher order number sense. Interactive media tools hold promise for providing meaningful learning experiences for children, but the complex nuances of learning, particularly in mathematics education, may require specific forms of scaffolding, like that suggested above. While it is quite simple to merely discard results that, like ours, show no significant difference between pre- and posttests, it is through qualitative analyses that we—as a field—can unpack the complications of learning and design more powerful interactive educational opportunities.

Conclusion

The preliminary results here indicate that while there were not significant learning gains between the pre- and post mathematics assessments, our preliminary qualitative analysis reveals intriguing findings can be explained in part by existing research in mathematics education and cognition. Our ongoing qualitative analysis examines the demonstrative behaviors of the study participants as they perform the required activities of the number knowledge assessment items. While this can provide the researchers with a deeper understanding of both participant engagement with a situated learning activity and the nuanced methods in which early learners demonstrate their knowledge of specific content, the suggestions for interactive media development proposed still stand. Interactive media is poised to dramatically change the field of learning, especially when pairing newly emerged technologies like the Kinect with tried-and-true educational interventions like *Sesame Street*. The results that are most useful for designers and mathematics educators, however, may be hiding behind a simple test that declares discouragingly: “No significant differences.”

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Playtesting *PlanetMania*: A Mobile Game for Museum Exhibits

David T. Schaller, Eduweb, david@eduweb.com
Barbara Flagg, Multimedia Research, Flagg@MultimediaResearch.org

Abstract: *PlanetMania,* a mobile game from the Maryland Science Center, is designed to be played by preteen visitors in the *Life Beyond Earth* exhibit. The card-based gameplay expands upon exhibit content and encourages interaction with the physical exhibit. Through extensive paper prototyping and iterative development, the project team revised and simplified the game content and interactivity, striving for intuitive game rules, age-appropriate scientific content, and engaging game play and learning outcomes — all in a museum environment where players have plenty of distractions.

Introduction

For over 15 years, museums have been incorporating handheld devices into the visitor experience, but until recently, these efforts have focused on traditional interpretation with didactic content (Dowden & Sayre, 2007; Filippini-Fanton & Bowen, 2008; Petrie & Tallon, 2010; Burnette et. al., 2011). Only recently have game-based projects emerged, such as the "Tate Trumps" mobile game from Tate Modern. Games are an enticing format for museums, because they are inherently engaging, motivating, and meaningful experiences (Schaller, 2011a, 2011b). However, because games require substantial attention from the player, they create significant design challenges to ensure a satisfying experience that enhances rather than distracts from the museum visit.

To tackle this challenge, a team gathered at the Maryland Science Center (MSC) in January 2012. The group consisted of the Principal Investigator, a consultant and project manager, MSC development and implementation staff, and the authors of this paper: a learning game designer and an independent evaluator. Supported by a grant from the National Science Foundation, the team's goal was to design and produce a mobile game, eventually named *PlanetMania*, to be played by visitors at a museum exhibit about astrobiology, which was also in development at that time. In contrast to traditional didactic mobile tours, this game would appeal to children (a large portion of MSC visitors) and could help them engage with the text and images of the Astrobiology exhibit (Klopfer et al., 2005). The game is available for iOS and Android devices from the *Life Beyond Earth* web page (http://www.mdsci.org/exhibits/life-beyond.html).

A Slate of Constraints

PlanetMania faced many constraints: two (audience and content) that are common to any museum project, plus several additional constraints of platform and environment that did much to shape the final product.

Subject Matter: Astrobiology and the search for life beyond Earth, focusing on recent discoveries of exoplanets (planets orbiting other stars) and the requirements for life on other worlds.

Audience: Museum visitors between the ages of eight and twelve, visiting either with their family or a school group.

Deployment Technology: Mobile devices, specifically those running iOS (iPhone, iPod Touch, and iPad) and Android operating systems. This dual-platform deployment (and our budget) meant we had to build the game in HTML and "package" it with PhoneGap, thus limiting potential interactivity.

Game Platform: A content management system (CMS) housing all game content, so the game could be instantly updated as exhibit components changed over time. Furthermore, with the CMS, museum staff could create new versions of the game for other exhibits. This placed substantial constraints on gameplay and presentation, since we had to design a generic game that could support any subject matter.

Exhibit Environment: MSC's *Life Beyond Earth* exhibit, which was being designed concurrently. This perhaps was the greatest constraint, for the game had to enhance and expand upon the exhibit content, while repeatedly redirecting the visitor's attention back to the exhibit. If we created a game that kept players glued to the screen—normally a sign of success—we would have failed.

The Answer is in the Cards

Given these constraints, we had to relinquish what is typically a major goal for learning games: tight integration of gameplay and content. When gameplay and content are separated, essentially operating on different planes within the game, players can easily ignore the content and instead concentrate only on the game mechanics necessary to succeed. And indeed, the design team quickly set aside some promising ideas for game-exhibit connections, since they would not be re-usable with other exhibits. Instead, we developed a game concept that emulated the scientific method using interchangeable scientific content:

> The game focuses on a question at the frontiers of science, to which no one knows the answer. For the astrobiology version, it might be "Is there life on other planets?" Players choose a hypothesis, then collect "evidence cards" as they explore the exhibits. When players have collected seven cards, they are prompted to support their hypothesis, choosing the best four cards that make a strong case for it. Players then submit this "hand" of cards to earn Astrobucks and a coupon to the museum store. (Draft design document, January 2012)

A card game design accommodated all of our constraints:

- Subject matter: Astronomy is highly visual, so text and images can convey a great deal of information.
- Audience: Children are generally familiar with card games, easing the learning curve.
- Technology platform: Card-based gameplay can easily be created in HTML and "packaged" as an app with PhoneGap.
- CMS-based game platform: Cards can serve as a generic template for server-based content.
- Exhibit environment: Cards can be "collected" using keycodes embedded in exhibit panels, thus drawing players' attention to the exhibit's different areas.

This format had one other benefit, which proved to be equally essential: It was quite easy and inexpensive to playtest with children using paper card mockups.

Test, Revise, and Repeat

After further development, we began playtesting the game with children. Over four rounds of paper prototyping (see Figure 1), we revised and refined both content and interactivity, all before writing a line of HTML. Then we tested again with paper mockups after formative evaluation of a digital prototype. On its own, the core gameplay worked pretty well. Children quickly understood the basic mechanics: collecting cards, employing wild cards, and combining cards for power-ups and to form "cases." Nor was the content, on its own, a serious problem. During playtesting, we found that most card content (about exoplanets, extremophiles on Earth, and the ingredients of life) was new to children, but they generally could make some sense of it, especially when they could connect it to prior knowledge.

The problem arose not from children's imperfect grasp of the content, which was probably typical for a science museum exhibit, but from what we asked children to *do* with it. The game required them not merely to understand the card content, but also to apply it, by deciding whether or not the card supported the hypothesis. Children made valiant attempts, but often their rationales were vague, uncertain, or even whimsical. Given their unfamiliarity with our science content, this task was simply beyond the cognitive ability of most 8-10 year olds, at least within our chosen game format.

So the problem was not purely with either the content or the gameplay. It was at the *intersection* of the two. Children could make rough sense of the card content, and they had no problem with the basic gameplay. But applying their nascent understanding of the card content in the context of the game rules proved too difficult for most children. Ironically, we had managed to create a game that required that players understand the content in order to play the game well — and that turned out to be the central problem with the game design.

Figure 1: Early Designs for Game Cards

That, at least, was how we interpreted the playtesting results. But because the *Life Beyond Earth* exhibit was still in development, playtests were conducted in a vacuum of sorts, absent the atmosphere of exhibit panels and interactives, making our conclusions tentative at best. Nonetheless, we had to address these issues before building a pilot version of the game for formative evaluation. So we simplified both the content and the gameplay and built the game in HTML to be tested in the museum.

This pilot version of the game would also be our first test of the card-collecting mechanic, since it required the exhibit environment. To collect cards, players must find three-digit keycodes (posted at strategic spots around the exhibit) and type them into the game. They draw two cards, then must answer a multiple-choice quiz question about astrobiology (with the answer found in nearby exhibit text) to earn a third card. We added this step to strengthen the game's connection to the exhibit. Players repeat this process until they have seven cards in their hand. Then they begin powering-up and making cases to support the current hypothesis.

The formative evaluation found that the game was appealing to children, with a 4.1 rating on a 5-point Likert scale (all formative citations are Flagg, 2012). Girls indicated greater sustained interest than boys over several rounds, perhaps due to the text-centric nature of the game (Chudowsky & Chudowsky, 2010). The majority of children liked the card-collecting task, with six out of ten players calling it the most fun aspect of the game. As one said: *"Getting the cards and seeing all the different planets and answering the questions, you had to work and think."* Also popular were the Astrobucks, which players earn to unlock and upgrade for a coupon to the museum store. Nearly half of the children said that was the "most fun" aspect of the game. However, one-third of children criticized the reading load: *"It's more like reading a textbook than playing a game. It's not too much fun."*

The evaluation identified a number of problems that minor revisions could fix. However, it also found that the game wasn't especially educational. While two-thirds of players could report something interesting they learned from the game, even players who appeared to understand the game had trouble choosing Evidence Cards that supported the hypothesis. Why did players have such trouble with this task in the pilot version, despite our revisions after earlier rounds of playtesting? We had two suspects:

- This task became more difficult when we moved from paper to digital cards, and when we added mini-cards in the digital game (necessary given the small size of phone screens). Each card appeared full-size (with a large image and complete text) when first collected, then shrank to a mini-card as it slid into the card array. Players had to tap each mini-card to enlarge it, which with seven cards onscreen became more cumbersome than with paper cards. This may have interfered with players' ability to scan and compare the card content in relation to the hypothesis.
- The exhibit environment likely distracted players from the game. This was to be expected, but ultimately we hoped it would be balanced by the presence of relevant exhibit content. However, because the evaluation was conducted in the *SpaceLink* exhibit rather than *Life Beyond Earth*, there was no related exhibit content to support the game content.

With less than two months before the exhibit opening, we drastically simplified the game design and completely redesigned the core tasks in the game. In the pilot version of the game, players collect seven cards and then choose the four cards that best support the hypothesis. In the revised game, players collect five cards, and upon collecting each card, make two decisions: 1) whether it matches the statement and then 2) whether to keep it in their two-card hand or drop it (see Figure 2).

Figure 2: Revised Game with two-part matching and choosing sequence

Finally, and most crucially, instead of requiring players to infer the relationship between cards and the hypothesis, we established a simple, obvious, one-to-one match between card topic and the statement (formerly “hypothesis”). This made the matching task (e.g. “Does this Evidence Card match the statement?”) much easier for children, both in terms of understanding the task at hand and the most likely correct answer. But it was also a gamble: the matching task was now so simple that players might easily make their decision based only on keywords or card design, ignoring the scientific content on each card.

The Game Meets the Exhibit

The game was released on the Google and Apple app stores in early November 2012. Signs near the entrances to *Life Beyond Earth* encourage visitors to download the game to their mobile phone (using the musuem’s free wi-fi signal) and play it as they explore the exhibit. After each round, their Astrobucks are added to their museum store coupon, which they can show (on their mobile device) to the store cashier to obtain their discount. Summative evaluation — in the actual *Life Beyond Earth* exhibit — was done a week after the exhibit opened (Flagg & Holland, 2013), employing a pre-post quasi-experimental study in which a sample of 24 9-11 year olds were interviewed prior to and after experiencing the game and exhibit as well as observed during their exposure to the game and exhibit. Three-quarters were girls, and 29% were African- and Asian-Americans. Each child was provided with an iPod Touch and instructed to “explore the exhibit as much as you want and use the game as much as you want and when you are done, we’ll talk about your experience.”

Do Children Play the Game?

Players most often completed four rounds of the game while in the exhibit, and two-thirds stayed in the exhibit for the 20 minutes allowed (see Figure 3) — though as invited visitors, they were likely to spend more time in an exhibit than an average visitor. All but one participant liked exploring the exhibit with the game. Half of the participants liked it “a lot” and about half liked it “somewhat.”

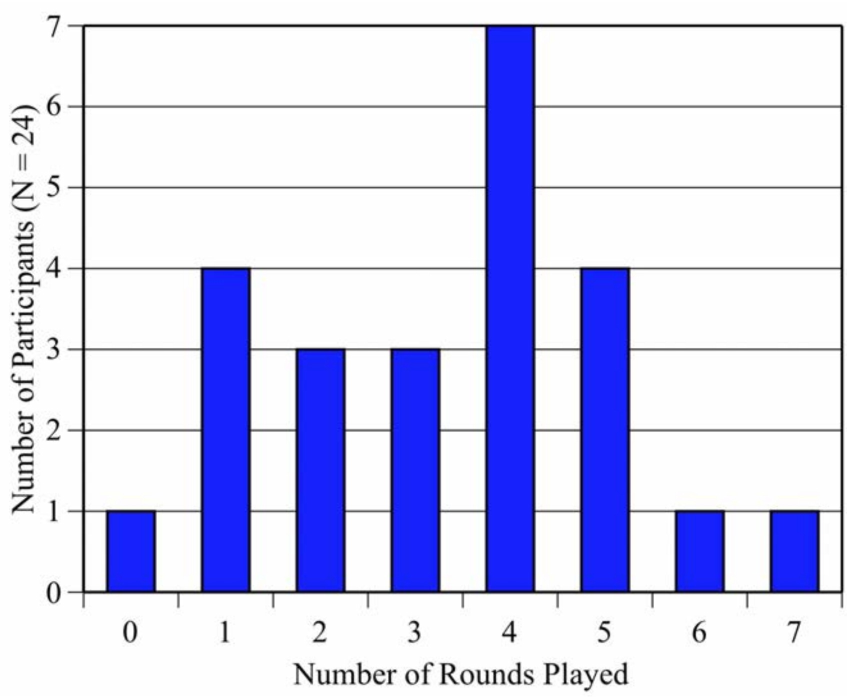

Figure 3: Rounds Played with PlanetMania Game

They exhibited a wide range of behaviors that fell into five patterns, defined by number of rounds played, scores, and interaction with the exhibit. A plurality (38%) of players drew on the exhibit to play the game but also explored the touchables and videos beyond what the game required; whereas 17% skimmed the exhibit with much less game-exhibit interaction. Some players (17%) focused only on the game, ignoring the exhibit; whereas others (13%) focused on the exhibit and ignored the game. Finally, 13% did not engage with the exhibit or the game.

A common concern about game apps in a museum setting is that young visitors will become immersed in the game and miss the museum exhibits themselves. *PlanetMania's* design encouraged interaction with the *Life Beyond Earth* exhibit via its keycodes and multiple-choice quizzes, which exposed players to most of the exhibit content. Three-quarters of our players interacted physically with one to six of the seven components.

Did the Gameplay Work?

The summative evaluation gave us our first look at the game in action in its proper environment, where we could finally see how all the elements worked together. Despite children's generally positive responses to the game, two-thirds of players reported difficulty at some point in playing the game. Most of these were usability issues which had a noticeable effect on player's experience, and we subsequently made minor modifications to address these issues. Of special concern: those players who did not understand a core task in the game – deciding whether or not each new card matched the Statement — usually reported that this matching task was 'hard' (29%). In contrast, the majority of players *did* understand that task and felt that it was 'just right' (58%) or 'easy' (13%) in terms of difficulty. Even so, a good number of players were unable to describe coherently their own matching process. Those who *could* reflect on their thinking revealed that the task is appropriate for this age group:

"I'd be looking at the picture and reading the statements and seeing if they are both alike and similar in a way. I was looking for key words in there and see if they match up."

"Life *as we know it" had a caterpillar picture and animals need the right kind of food, and that matched with the statement. It's a challenge but you can't learn unless you advance. Hard but a good challenge."*

Did the Game Enhance the Visit Experience?

Without a study that includes an exhibit-only control group, we cannot conclude that the game experience made a significant difference in visitors' learning outcomes, but our pre/post interviews reveal that almost all of the participants acquired some new or more sophisticated understanding about astrobiology. Moreover, children frequently specified the game as the source of their new knowledge. Table 1 shows players' increase in knowledge on six questions related to exhibit and game content. Almost all (96%) participants acquired knowledge related to at least one interview question, 46% to two questions, and 13% of the participants demonstrated new knowledge for three of the six questions.

Open-ended questions before and after exposure to game and exhibit	Players with prior knowledge beforehand	Players who acquired new knowledge from game and exhibit
Why do scientists think there might be life beyond earth?	38%	17%
Describe some ways that astronomers can detect planets around stars other than our sun.	42%	33%
What do scientists look for when searching for life on other planets?	58%	38%
What kind of life do scientists think we might find on another planet?	13%	33%
What things do you think life needs to survive on other planets?	100%	0%
What are some extreme or strange places or environments on earth where you think life can be found?	54%	38%

Table 1. Percent of Participants with Knowledge Prior to Game/Exhibit Exposure and Knowledge Acquired from Game/Exhibit Exposure

A Platform to Build On?

PlanetMania successfully met its goal to make the *Life Beyond Earth* exhibit more accessible, engaging, and understandable for preteen visitors. Perhaps most notably, the game struck a good balance, as most players successfully split their attention between the game and the exhibit. This was the product of both intentional design and some luck, since we could not test this feature until the game was released. In retrospect, we learned less from paper prototyping than we realized at the time, due to the differences between the paper mockups and the digital game, along with the absence of the exhibit environment. This forced more drastic revisions after formative testing of the pilot game on iPod Touch, blunting the cost advantages of paper prototyping. In the future, we might move to digital earlier in the process and construct simple mockups of key exhibit panels to test the game in a more authentic environment. Revisions to the digital game are likely inevitable, so it's better to discover those sooner than later.

While the game was well-received, its reliance on text content and repetitive gameplay may limit its appeal. Of course, those elements are also what allow the core game platform to be repurposed for entirely different exhibits, simply by populating the game with different card content and questions. How easily could we repopulate it with new content on another topic — and would the gameplay work as well? The only way to truly answer these questions, of course, is to try it with another exhibit. Such an effort is now underway with an exhibit on electricity at MSC, scheduled to open in early 2014.

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Order Versus Entropy in Virtual Spaces: Takeaways from Three Experiments in Virtual Behavior.

Dr. Edd Schneider, University of South Florida, efschneider@usf.edu
Dr. Anthony Betrus, SUNY Potsdam, betrusak@potsdam.edu

Abstract: This presentation summarizes the results of three experiments on how users behave in open virtual environments with varying degrees of guidance. The goal is to provide information about how to best keep users engaged with the instructional content, rather than the environment itself. The three studies summarized here used Grand Theft Auto games with modified graphics and/or rules, and measured subject reactions. The first study asked subjects to take the role of a firefighter to test adherence to research instructions against the temptation of virtual experimentation. The second study was similar, and tested adherence to an easier, yet tedious task. The third study had one group of subjects select tasks of varying difficulty on their own while a second group had their tasks selected by the experimenter. The results, framed in current learning theory, provide insight on techniques for getting learners to stay on task in virtual worlds.

Introduction

Online virtual environments have been part of the Instructional Technology landscape for over a decade. For example, the decade-old world of Second Life launched in 2003 and hosts thousands of educational locations and groups. In the first five years over 65,000 students have used Indiana University's online science space, Quest Atlantis, to explore science. The adoption of this new technology creates problems as well as opportunities for Instructional Designers. One of the most basic challenges is keeping users on task.

Instructional designers having to consider aberrant behavior of learner's 3-D avatars in a virtual education space isn't science fiction. For example, Second Life hosts educational environments on subjects from outer space to archaeology, which are shared by users from around the world. Universities such as Penn State host campuses in their virtual space. However much like the wider internet, the game is also home to areas and content totally inappropriate for education. Wide areas have been dedicated to erotica, gambling, and drug abuse.

The three experiments at the foundation of this session measured how users in a very open virtual environment reacted to different kinds of instructional scenarios. The first one tested dedication to instruction in a frustrating scenario, the second tested dedication to instruction in a tedious scenario, and the third tested dedication to instruction in a scenario where subjects could choose tasks with a range of difficulties. In short, the impact of difficulty, tedium, and choice on virtual behavior was investigated.

Previous Research

The term 'virtual environment' has had a changing meaning. Some academic descriptions have been very specific, dictating that virtual environments must have visual representations of space. (Tomek, 1999) Others consider simpler, web-based, text-centric message systems to be virtual environments (Blanchard, 2004). There is an implication of multi-user, online functionality in some definitions of 'Virtual Environment' as well. (Redfern et al, 2002)

For the purposes of this research 'virtual environment' means digitally created, interactive spaces with 3-D rendered graphics. The virtual environments used here do have online connectivity, but it was not used in this research.

The basics of the Instructional Design process dictate that the need for a 3-D virtual environment should be considered before opting to use a 3-D virtual environment. Part of that consideration should involve user training. Virtual environments require specific and immediate training for users, unlike more traditional media such as written text and video. One analysis of Second Life indicated training users can be difficult, and encouraged practitioners to consider if other delivery systems meet their instructional needs instead. (Berge, 2008)

The impact of virtual stimuli on task performance has been assessed on other ways. One study (Zabanka et al, 2004) found that research subjects reacted similarly to having their tasks observed by a real human and a virtual avatar. Other research (Rickel & Johnson, 2000) has found success in using virtual agents to guide task-based training. No research could be found directly dealing with keeping individual users on task in interactive, 3-D spaces.

Experiment goals & design:

The first experiment was designed to investigate how long will subjects adhere to a frustrating assigned task in a virtual space. In this experiment, subjects were given control over a fireman character, standing in front of a fire truck, parked in front of a fire station. Subjects were read a script thanking them for testing a new fireman game. Their only assigned task was to play the game as a firefighter. They could fight fires, but doing so was not easy. The virtual behavior of players was noted and quantified. Aspects of their behavior, such as the time at which they abandoned playing the game as a firefighter, were especially important.

The second experiment was designed to investigate how long will subjects adhere to a tedious task in a virtual space. In this experiment subjects were given a car on one side of the Grand Theft Auto map, and simply asked to drive to another point on the map. The map of the game is expansive, and the drive, performed as an actual driver would do it, was designed to take between 10 and 20 minutes. Again, the virtual behavior of players was noted and quantified, and again in this instance the point of task abandonment was of particular importance.

The third experiment was designed to investigate if giving subjects choices in task selection would impact performance on tedious tasks in a virtual space. In the first two experiments the participating subjects were all given identical tasks at the beginning. In the third subjects were split into two groups. The first group was given instructions to choose tasks themselves, and the second had the tasks chosen for them. While the first two experiments were designed to measure the impact of factors design to negatively impact task performance, the third experiment was designed to measure the impact of a variable intended to increase task performance. Studies have shown that giving subjects choice over tasks can positively impact task completion. (Ramsey et al, 2010; Mechling et al 2006)

In each study 40 different subjects were recruited from the campus community, with the age range between 18 and 58. The gender split among subjects was approximately 30% female and 70% male. For the first study a modified version of Grand Theft Auto 3 for the PC was used, and in the second two studies Grand Theft Auto 4 for the Xbox 360 was used. In each the player played the game under laboratory conditions with a research observer. The play period for each study was 20 minutes.

Results and Interpretation

The experiments' results provide several statistically clear patterns of behavior.

-Without guidance, all subjects abandoned their virtual role and experimenter instructions eventually.

In the first study subjects were asked to play the game in the fireman role, within ten minutes of playtime not a single subject was still in the fireman role. Although the willingness of subjects to try and stay in character varied, and not all subjects turned to violence, all subjects showed some level of experimentation. The adherence to the fireman role was assessed by two indicators, the point at which the player stopped showing concern for pedestrian safety was used as an indicator of the beginning of experimentation, and the point at which the player started actively killing pedestrians with weapons was used as an indicator of the subject fully abandoning the fireman role.

-Males are much more likely to experiment with violent behavior in a virtual space.

The virtual space used in these experiments is filled with computer controlled characters. The average number of kills for male subjects in the gameplay time period was consistently at least double the number of kills for female subjects. None of the experiments asked players to kill digital pedestrians, and more specifically the instructions gave subjects tasks they were supposed to be engaged in. Male subjects also fired more bullets from their guns, even though they were not asked to use guns. There was also a much wider standard deviation in behaviors related to violence. In the first experiment, with the frustrating task, male users killed on average 30.6 people in 20 minutes, while women killed 11.1 in the same period. In this experiment's design the subjects were given instructions and allowed to play for 20 minutes. In the second experiment men killed on average 16.4 pedestrians and female subjects killed 8.2. (See Figure 1) In the third experiment the tasks were smaller, and regardless if they chose their own tasks or were assigned them, the number of kills dropped dramatically. On average, male subjects only killed 1.2 pedestrians, and women on average killed 0.6 pedestrians.

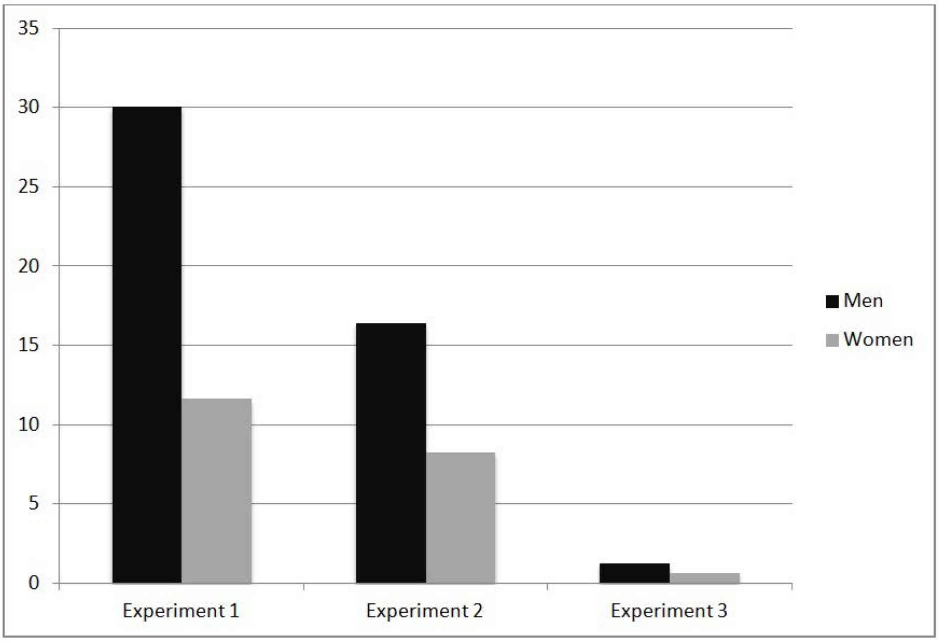

Figure 1: Number of Kills Per Experiment by Gender

-More structured tasks produced greater adherence to the tasks.

The three experiments presented subjects with three different tiers of tasks, each more clearly defined than in the experiment that preceded it. As the specificity of the tasks increased, subjects spent significantly more time trying to complete the tasks. In the first experiment all subjects abandoned the fireman role for the majority of the play period, in the second study most subjects completed the boring drive, before entering an exploration phase, and in the third study all subjects completed multiple tasks with extremely little experimentation from any participants.

-Structure and choice combined produced the most desirable outcome.

The third experiment contained two research conditions, one group could choose tasks and the other was pre-scribed tasks. The group that had their tasks chosen for them completed more than the subjects who were able to choose their own. At the same time, subjects who selected their own tasks chose and completed a relatively similar number of difficult tasks, and had more fun with their experience.

Finally, it should not go without mentioning that the Grant Theft Auto series of games was chosen as Virtual Environments because they were deemed to be among the most difficulty environments to keep people on task in. The game is designed to steer the player to menace and mayhem, with distraction and potential interaction at every turn, with pedestrians, criminals, police officers, or simply the allure of the buildings and streets themselves. Our rationale was simple: if a strategy is successful in keeping users on task amidst the chaos of Grand Theft Auto, it should work in any virtual environment. So while in the first experiment users were nowhere near staying on task, in the second, things got a little bit better, and finally in the last experiment they stayed on task for the full time, regardless of treatment type. And this is where perhaps the most fascinating part of the study lives: in the two varying treatments. One was picked to give the players ownership, and the other with tasks deliberately chosen to scaffold the learners from easy to medium to difficulty tasks. If success is measured by how much fun a player had, the ownership group would win. if success is measured by difficult tasks alone, the treatments were equal. If easy, medium, and hard tasks are all considered, the group that was given a pre-chosen task order was more successful. Whichever lens you choose to look at the results through, at the very least they stayed on task in both cases, and in the world of GTA that's not done easily.

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Using Video Games to Trigger Interest Emergence and Task Engagement in Science Classrooms

Stefan Slater and Shannon Harris, University of Wisconsin – Madison
slater.research@gmail.com, shannonharris.research@gmail.com

Abstract: Interest is a powerful predictor of subsequent academic motivation and success, and behavioral psychologists and teachers alike have struggled to find the best method of getting students excited and engaged in classroom activities (Hidi & Harackiewicz, 2000). The current study proposes that video games are an excellent vehicle for producing an initial trigger to allow interest formation to take place. By using the educational video game *Virulent* in a 7th grade science classroom, it was demonstrated that in-class educational video game play led to higher task involvement for a science-based learning activity, as well as greater levels of interest, enjoyment, and free-time media use, when compared to a more traditional reading assignment. Methodological shortcomings of the present study and future direction of the research are discussed.

Introduction

Social psychologists have defined two types of interest: situational and individual (Hidi & Renninger, 2006). Situational interest describes initial curiosity and attention given to an *object or concept*, and individual interest describes beliefs about the object or subject being ascribed and attributed to *an individual's sense of self*. An individual's interest in a topic, subject or activity consists of two components – a situational component of interest that is *context-specific*, and an individual component that refers to *a person's preexisting beliefs, values, and affect for the content*.

Emergence of situational interest is sensitive to factors such as the medium through which information is presented and to the external support that an individual receives, e.g. through a teacher, friend, or online community. As an individual proceeds from novice to expert, factors of situational interest can be gradually replaced by factors of individual interest. For example, a student interested in physics may find a dense textbook too difficult to read, while a student well-versed in physics may actively seek out and read the same textbook to add to his or her knowledge. The first student did not read the textbook due to situational constraints, while the second student understood the value of adding to his or her physics knowledge and sought out the textbook independently.

Research has repeatedly shown that interest in a subject or topic is a strong predictor of later performance and motivation (Hulleman & Harackiewicz, 2009; Shen, Chen and Guan, 2007). For interest to emerge, however, an initial stimulus must capture an individual's attention and cause them to engage with the content. Current research hypothesizes that video games can be effective vehicles for triggering situational interest, especially when compared to standard classroom instruction techniques (e.g. articles and book readings or movies and video viewings).

Additionally, research has repeatedly observed high levels of student task engagement and interest when using video games to introduce students to new school-related topics such as history (Squire 2004) and science (Gaydos & Squire, 2010; Ketelhut, Dede, Clarke, Nelson, & Bowman 2004; Steinkuehler & Duncan, 2008; Squire, 2011). This enhanced engagement associated with video games is especially pronounced for students who do not perform well in traditional classroom environments (Steinkuehler, 2006). Outside of videogames, task engagement is also a good predictor of achievement, motivation, and affect towards a specific learning content (Lee & Anderson, 1993).

The current study hypothesizes that educational videogame play is a more powerful means of promoting situational interest emergence and task engagement generation than traditional forms of classroom instruction. It is hypothesized that students will report higher levels of interest and enjoyment for educational videogame play, and that they will report feeling more involved in the task when playing an educational video game than when they work with traditional classroom instruction methods.

Methods

To fully address these hypotheses, the current study was designed to examine differences in levels of task engagement that students displayed following a 15-minute session of either educational video game play or reading followed by video clips. Prior levels of student interest and knowledge of biology were measured, along with student task involvement for each activity. After both activities had been completed, students were asked to select which of the two activities they preferred based on how interesting, how enjoyable, and how informative they were.

Subject Pool

Participants in the study were 7th grade science students (n = 56, mean age = 12.48) drawn from a middle school in the midwest, with IRB approval and parental and minor consent. The students had no prior knowledge of virology topics in a formal school setting. Males and females were almost evenly split, there was one more male than female student. The subject pool was predominantly caucasian, with African Americans, Asian Americans, and Hispanics comprising 5% of the sample.

Activities

In order to measure participant interest in different presentation styles and engagement with different forms of learning media, while maintaining a robust learning atmosphere, experimental stimuli were presented as in-class introductory activities to a two-week virology and bacteriology curriculum unit. The two activities, educational video game play and a typed summary about viruses with embedded videos, comprised the majority of the students' class for that day.

The first activity consisted of a Word document introduction about viruses. Topics included: what a virus is, how it reproduces, what it is made of, how it infects a cell, and how the body defends against it. A brief section on vaccinations was also included. If participants completed the reading exercise early, they were also able to watch several video clips of viral life cycles.

The second activity consisted of the educational video game *Virulent*, developed as a collaboration between organization A and organization B. In *Virulent*, players assume the role of the Raven virus, which is based on the vesicular stomatis virus. During the game, players begin as a virion infecting a host cell, and explore viral life cycles and cellular defense as they attempt to make more virions and further the infection.

Both treatments (the traditional learning activity and the *Virulent* activity) were given to all students to ensure equality in dispersion of the educational resources, but in different orders, so that the impact of each activity could be measured individually.

Assessment Tools

Several assessment tools were developed to measure interest emergence and task engagement. These domains were measured through survey tools adapted from Linnenbrink-Garcia et al. (2010), Cole Gaeth and Singh (1986), and Schaufeli, Bakker and Salanova (2006).

The introductory questionnaire consisted of basic demographic information, initial measures of interest in biology, prior knowledge of biological topics, and prior engagement with the presentation media.

The interim questionnaires, administered after each of the two activities, consisted of questions designed to measure relative task engagement in the activity. Participants also completed two short free-response questions concerning specific things they liked or disliked about doing the activity. The interim questionnaires were nearly identical, except for the final bank of questions. The first interim questionnaire contained a four-item section on the perceived value of learning about viruses, as an indirect method of measuring interest and relevance. The second interim questionnaire asked students to compare the reading and video game activities based on which was more interesting, which was more fun, and which was more informational. These questions served as a measure of situational interest: which activity was more enjoyable, and which was more educational.

Procedure

The study began on the first day of a two-week unit on viruses and bacteria. Participants were introduced to the experimenter, and instructed to complete the introductory questionnaire before beginning the activities. Student assent and parental consent had already been obtained prior to the experimenter's visit. After all students had completed the introductory questionnaire, they were instructed to read the top of their first questionnaire. The first paragraph of this questionnaire contained instructions for which activity the students were to begin with. Half of the students in the study began by playing the video game *Virulent* for 15 minutes and half began by reading the virus summary and watching videos. The instructor had already posted both the game and the reading activity to her class website, therefore, the methods of presentation were not different than what the students were used to seeing. When 15 minutes had passed (as timed by the experimenter), students were instructed to stop the activity and complete the first questionnaire. After all students had completed the first questionnaire, the experimenter instructed students to do the activity that they had not yet done - students who began by playing the game would now do the reading, and vice versa. These directions were also printed in bold on the top of the second questionnaire, to ensure that all students interacted with both activities. After another 15 minutes had elapsed, students were again instructed to stop the activity and complete the second questionnaire.

If any time was left over after completion of the second questionnaire, students were free to return to either of the activities until class ended. The class instructor also led informal discussions about viruses to fill any additional time after the completion of the paradigm.

Results

Cronbach's alphas were used to validate the item inventories used in the experiment session. To analyze differences in task engagement between reading and gameplay, a one-sample *t*-test was used.

All response inventories were found to have a Cronbach's alpha of at least .8 (prior knowledge = .884, prior interest = .951, task engagement I/II = .944/.950, utility value = .885).

A main effect of presentation format on task engagement was found, $t = 3.249$, $p = .002$. Students were more engaged in educational gameplay than in readings and videos.

Students were also more interested in, and reported more enjoyment from, the video game as compared to the reading activity. 73% of students reported that the game was more interesting than the readings, and 75% reported that the game was more fun. However, only 15% of the students reported that the game contained more information. While this supports the hypothesis that educational video game play can be an effective method of generating situational interest, more data is necessary to understand any effect that its perceived lack of informational content may have on subsequent learning.

Outside of school, after the experiment, students also recorded more page views for *Virulent* (221) than the reading exercise (137) and instructor's curriculum introduction (124) on the class website. These data further reinforce that, for many students, *Virulent* was a more effective trigger for situational interest in viruses and virology than traditional forms of classroom instruction.

Conclusions and Future Goals

Students reported higher levels of task engagement, and displayed greater amounts of situational interest emergence after playing *Virulent* when compared to a more traditional classroom instruction method. These results confirm the hypotheses that well-designed educational video games can be an effective trigger for situational interest emergence, as well as an effective means of generating task engagement. Importantly, students displayed higher levels of interest in the video game even outside of the experimental setting, in their own free time.

Despite these results, there were numerous technical difficulties encountered when bringing *Virulent* into the classroom that hampered further engagement and interest in the activity. First, *Virulent* was originally designed for the iPad, with a touch and drag interface for controlling the virus. When *Virulent* was brought into the classroom, however, students played the game on school-issued laptops. In the personal experience of the experimenters, attempting to play *Virulent* on a laptop touchpad increases the (already considerable) difficulty of the game to a great degree. Future studies should make greater attempts to ensure that the game can be played on some touch-based device, preferably a compatible iPad. Second, although most of the instruction and guidance provided in *Virulent* is audio based, many students did not have headphones and did not turn up their volume during play. This led many students to comment that the game was frustrating, and that it didn't provide very good instructions. Finally, the second level of *Virulent* is especially challenging, and requires that players elude antibodies for an extended period of time (around 5 minutes). With the entire activity only lasting 15 minutes, and with the previously mentioned problems in game control, a very small percentage of students successfully completed this level within the available time. It is likely that the contrast in perceived information between game and reading assignment stemmed from the inability of most students to complete this level and progress further in the game. Considering the substantial methodological problems that were encountered in the research, it is a true testament to the ability of a videogame to excite and engage young students and an accomplishment that positive results were found at all.

Current interest research maintains that interest is a content-specific construct, despite stating that situational interest is influenced heavily by factors external to the content (Linnenbrink-Garcia et. al., 2010). Situational interest is a prerequisite for subsequent interest development; therefore, research on interest emergence should consider the factors external to content that play a role in its emergence, such as the medium through which the content is presented, or the types of external support an individual receives during situational interest formation. This gap in the discussion of factors of situational interest is neatly filled by using an engaging content platform such as an educational video game. Educational video game researchers have suggested that students display strong interest in video games in educational settings, however, detailing the development of individual interests requires further investigation. By merging these two bodies of research, the intrinsic engaging qualities video games can subsequently be harnessed in more formal educational settings.

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Professor to Producer of eBooks with computer games

Glenn Gordon Smith[1], Mieke Caris[2], Jack Drobisz[1]
University of South Florida[1], IMapBook LLC[2]
glenns@usf.edu, miekecaris@gmail.com, Jack@usf.edu

Abstract: A professor describes his experiences directing and producing a science fiction novel, in eBook format with computer games, featuring solar system science content, for sixth graders. The embedded computer games were designed to both move the plot forward and act as stealth assessments of comprehension and science content. The idea of this project emerged from a needs analysis of a 6th grade science teacher and science class from a private Christian school. The teacher suggested a strong need for better materials to teach highly spatial solar system content, including phases of the moon, eclipses, tilt of the earth relative to its orbit as the cause of seasons, etc. Our research group decided to create a novel that would be an exemplary piece of content, and an exemplar of web-based eBook with computer games to teach science and language arts content.

eBooks plus computer games: A new format and its rationale

For today's children, the dominant storytelling media are computer games, video, TV, web-pages and texting (Fourie, 2008; Ryan, 2004). However reading skill is, and will continue in the future, to be vital to children's education and careers. Independent reading is an important factor in reading skill (Mol & Bus, 2011). Across western, industrialized countries, children's recreational reading is declining (OECD, 2011). The percentage of students reading for enjoyment daily dropped in the majority of Organization for Economic Co-operation and Development (OECD) countries between 2000 and 2009 (OECD, 2011).

Electronic media are converging. Text, audio, video and computer games combine on webpages and hand-held devices. With eBooks crowding out hardcopy books, eBooks and computer games will converge. Early evidence includes multimedia books for emerging K-1 readers (Smeets & Bus, in press). However, for sixth graders, a group who clearly needs such a convergent media to address reading problems, there is no such product.

Our research group invented a medium that combines books with computer games, in order to revive adolescent interest in books, scaffold learning, provide stealth assessment and tracking for teachers. In this new form of book, called IMapBooks (short for Interactive Map Books), each chapter of text is followed by a computer game that stealth assesses comprehension of the last section of text.

The IMapBook software suite contains: (1) IMapBook Reader, a web-based eReader for students to read/play eBooks plus computer games, including bookcase and achievement badges, (2) Authoring System, for laypersons to input books and computer games into the system, and (3) Administrations System including a system to register new users, and reports from the database, to provide teachers and parents reports on book reader responses and who has registered and when. The IMapBook system is designed both as an eBook/computer game system and a suite of tools for research.

There are three types of IMapBook games: (1) retroactive games, which stealth assess comprehension of the previous chapter, (2) progressive games, where gameplay moves the story forward, and (3) predictive games, where readers hypothesize upcoming possible storylines.

Games in multimedia books can result in poorer comprehension and retention if they are too appealing and distract from the book (Kooy-Hofland, & Bus, in press). Thus the games in IMapBooks are designed to avoid overwhelming and distracting from the reading, but must rather to complement the reading. For instance one type of games is *inference games*, which include a clickable lexicon of words which the player clicks on to produce a short sentence, or inference about content from the previous chapter of text just read. There are also hotspot games, and drag and drop games, both of which are also well suited for the reader to visualize what they have just read in the story.

The professor has conducted six studies yielding many important results, including: (1) fifth graders comprehended and retained spatial information from stories, such as settings, characters movement and locations of objects, significantly better when reading books with computer games, versus traditional books with maps (Smith, 2012) and (2) Chinese undergraduates studying English as a Foreign Language (EFL) learned significantly more new vocabulary with web-based text and computer games than in a control condition with their usual study method, hardcopy text, lists of words and multiple choice questions) (Smith, et. al., in press).

Theoretical basis

The IMapBook concept is to embed in text narratives computer games that support reading comprehension through design principles motivated by the psychology of reading, specifically through supporting readers' situation models and inferencing which are described next.

High-level reading comprehension involves three cognitive representations: surface code, textbase, and situation model (van Dijk & Kintsch, 1983; Graesser, Mills & Zwaan, 1997). The surface code is the verbatim text. The textbase is the set of logical propositions explicitly in the text, without further inferences. The situation model is the "cognitive representation of the events, actions, persons, and the situation, [e.g., what] a text is about" (van Dijk & Kintsch, 1983, p.11-12).

The situation model is a mental model of the story people update to reflect changes from new events from each sentence. It is the joy of reading an exciting book, the escapist "mental leap into imagined worlds" (Zwaan, 1999, p. 15). The situation model has five dimensions: character(s), goals of characters, causal (how one event changes the trajectory of the story – the house floods, the family moves in with relatives), temporal (flash-forwards and flashbacks), and spatial (where in the setting events happen) (Zwaan, Langston, and Graesser, 1995; Zwaan et al., 1998).

To go from textbase (explicit logical propositions in the text) to situation model, readers fill gaps by inferencing, i.e, using "two or more pieces of information from a text to infer a third piece of information" (Kispal, 2008, p2). Information sources include: a) the text, b) readers' knowledge structures, such as schemata (e.g., knowing that wolves are dangerous is a vital schema in Little Red Riding Hood), and c) the context of the text (e.g., the author, reader, setting and the reading task).

Flashback - history of the project

Since 2007, my IMapBook research group, in the Instructional Technology Program, Dept. of Secondary Education, College of Education, U. of S. Florida, has researched eBooks with computer games. In a technology called IMapBooks (patent pending), chapters of text alternate with computer games. Each chapter of text ends in a computer game that can only be won with accurate reading of the previous chapter and inferencing (Graesser, et. al., 1994). The reader has access to current and previous chapters, but only gains access to the next chapter on wining the game. IMapBooks are backwardly compatible with all narrative books. All books can be converted to IMapBooks.

With the $5,000 of generous internal funding from USF, and the creative efforts of masters and PhD students working in a three-credit course, the professor developed (Prototype Game Research), our group has accomplished a lot. We have submitted a patent, created prototypes of books with computer games, first with pen-top computers and microdot paper, and more recently with Web-based eBooks and computer games, using Html5, xml, Javascript, and PHP. We have published papers in peer-reviewed journals (Smith, 2012; Smith, et al., in press, Smith, Majchrzak, Hayes, & Drobisz, 2011) and in peer-reviewed conference proceedings (Smith & Olkun, 2011).

During this evolution, we learned a number of things: (a) design games so that comprehension of text is required to solve them, not exploratory play without reading the text, (b) approximately 1,000 words of text per each game, based on research, (c) how the games can be used to emphasize different aspects of text (and help readers to better learn & retain), i.e., 5th graders learning spatial dimension of situation models (PICTS) and college EFL students learning new vocabulary

Structure of the research and development group

All work on eBooks with computer games is conducted within a graduate course in instructional technology called *Prototype Game Research*, developed by the director/professor. Each semester there is a new group of students, with a different set of skills and attitudes. One semester, the class has a lot of designers and one graphic artist; another semester a number of programmers, but few designers and no graphic artist. The skill gaps are filled in by alumni of *Prototype Game Research*, volunteering in their spare time. For new students, there is always a learning curve of a three to four weeks as the students come up to speed on understanding eBooks with computer games, the design process and how to use the software suite. At the beginning of the semester, we set goals based on current products and research studies. Prototype Game Research meets once a week. Students get individual assignments related to the current projects, and then the following week report on their progress on the assignments.

There is great esprit de corps in the class because students realize they are not working on canned class assignments, but are working on something real. The students also realize that they are, at the extreme cutting edge, working on something no one else in the world is working on, web-based eBooks with computer games. Each graduate student finds their niche in the group, according to their talents. There is a saying that “once in Prototype Game Research always in Prototype Game Research.” Many students continue contributing the group long after the semester of credit is over. All alumni of the class know they can count on the professor and IMapBook family to help them with their careers with recommendations or other supports. But of course such an in flux work force presents many management challenges. The professor directing the group has had to wear many hats: teacher, writer, creative-director, and above liaison to and manager of skilled people from a variety of disciplines: designers, programmers, artists, artists and educators.

Writing a science fiction novel with computer games

After some small prototypes, research studies and peer-reviewed publications, our research group decided we needed one larger piece of exemplary content, an original novel in IMapBook format, to market and show to potential investors. For broad appeal, we wanted to develop an eBook novel that could work both for science and language arts, for sixth graders, our target audience. We also decided that the product must be an exciting and compelling novel for sixth graders. Educational games often are not compelling games, because the education content gets in the way of the games. Similarly, if kids don’t want to read the story, no amount of games and educational content will save it. Therefore, a major priority was that the games and education would not get in the way of the novel. Rather, the games and educational content should be “one” with an exciting, compelling novel that sixth graders would happily read and play.

As our IMapBook group is hosted in an Instructional Technology program, with most of the researchers being Instructional Technology Master’s students, we used the ADDIE instructional design model to develop this eBook novel with computer games. The ADDIE model is a common instructional design model, where the acronym stands for different sequential phases: Analysis, Design, Development, Implementation and Evaluation (ADDIE).

During Analysis phase, we conducted a needs analysis with a 6th grade teacher and her sixth grade class, in a private religious school, call it Hoffner Christian Academy. We chose to work with this private religious school because it is extremely difficult to get quick Internal Research Board (IRB) approval to work in public schools. Even when just providing new learning materials to a public school, principals will often seek an OK from the highest level of their county district department of education. Given the emphasis on standardized testing, and the focus on curriculum to support performance on standardized testing, it is difficult to get teachers in public schools fit in time for experimental supplementary materials not proven to increase test scores. In fact, as an educational researcher, the professor often feels that he is assumed to be guilty, until proven innocent. With the miracle of the internet, the professor has often found it easier to circumvent IRB and county school district approval by conducting research in other countries, without such aggressive IRB, such as Turkey, Finland and China. In any case the choice of a religious school dovetailed with our proposed market, home schooling parents, who often keep their children at home for religious reasons.

Four students in the research group conducted a Front End Analysis, including: (a) interviewed the teacher of Hoffner Christian Academy’s 6th grade science classes to find out her suggestions for developing the CBT content, (b) collected documents related to content (ex. textbook, lesson plans, and assessment items, (c) administered a pretest to students to see what they already know about the content, (d) administered a survey to the target audience (students) to find out what they like/dislike about the solar system, computer instruction. Based on the FEA Design Implications, the product should: (a) be designed in 30-minute modules to accommodate the time allotted for the students to use the computer lab, (b) incorporate games, as 72% of students reported games as their favorite computer activity, and (c) he content should be developed from the school’s textbook and address the information contained in the pretest.

During informal interviews, the sixth grade teacher, suggested that certain solar system content with spatial content was challenging for her students: (a) seasons caused by tilt, of the axis of the earth’s rotation, relative to Earth’s orbital path, (b) lunar phases, and (c) eclipses. One of the graduate students in our group assured us (and backed it up with common core standards) that seasons, lunar phases and eclipses, were also part of 6th grade public school curriculum.

The sixth grade teacher gave me a copy of their science textbook, along with tests, quizzes and worksheets for various units. The professor scanned the solar system chapter, and distributed it to the graduate students in his research group. The textbook presented science content in an engaging way, but for a few in the research group who were not religious, certain passages in the science textbook were a culture shock:

> Copernicus believed that the Sun was the center of the universe and that the planets revolved around the Sun. For this startling publication, Copernicus was considered a heretic. Only after many years did scientists prove that the Sun is indeed the center of our solar system. God's orderly pattern for the universe allows man to prove mathematically ideas that he cannot prove experimentally (Sixth Grade Science Textbook, used in Christian School).

So that our IMapBook would be amenable to both religious and secular schools, we decided to focus on science content, but not to explicitly mention religious content or use any religious slant.

As part of the Design phase of the ADDIE model, we brainstormed different plot ideas, and characters, that would fit well with the solar system content. We employed "rules for brainstorming" that the professor originally heard in a workshop at GLS in 2010: (1) Quantity over quality (not just two, as many as you can), (2) No judging (especially no self-judging), (3) Go wild, (4) No "but"s just "and"s, (5) Combine ideas, (6) Get visual (sketches). At group meetings, researchers for five minutes individually wrote down, on "post it," notes as many plot ideas as possible. We then compiled favorite ideas and wrote them on a whiteboard to discuss. We also generated plot ideas at home and brought them to the meetings. All ideas were evaluated along several criteria: (1) how integral solar system content was to the plot, and (2) the potential of the plot for a compelling scenes, and a compelling story that sixth graders would enjoy reading.

Finally, we decided that the setting should be aboard a spacecraft within the solar system. We decided that the main characters should be two 11 year olds, a boy (Adam) and a girl (Shiranna), to appeal to both genders. After several weeks, considering dozens of different plot ideas, we selected this plot: Two eleven-year-old children on a spacecraft in the solar system, awake from hibernation to find they are alone. All the adults on the spacecraft are still in hibernation, and cannot be awakened. The two 6^{th} graders are then confronted with earth-shattering problems that relate to solar science content.

One of the students in our research group, John, has a Bachelor's in Physics and Astronomy. John became our Subject Matter Expert, or as posh Instructional Designers casually say, our "SME." John elaborated the plot into a more detailed scenario that might fit physics and solar system content as a causative element in the plot. Adam and Shiranna, on a shuttle from Earth to Venus, awake from hibernation to find that the spacecraft has been damaged through a collision with a small asteroid. The damage has made it impossible to awaken the adults. Adam and Shiranna soon a receive a message from Earth, saying that a planetoid sized asteroid is on its way into the solar system, on a course close enough that its gravitational pull will change the tilt of the earth, potentially catastrophically changing the Earth's seasons. Adam and Shiranna, being the closest humans to the asteroid, are called on to find a solution. The director of the research group elaborated the plot outline into a long short story, including brief ideas for computer games. Designers in the research group elaborated on these game ideas, with written game descriptions and storyboards. With just two characters, Adam and Shiranna, and the paraphernalia of the spacecraft, the introduction of science content into the games felt very artificial. The director of the project suggested we add a third character, a small cuddly robot commercially, designed for companionship and recreation, called Cheeky. Since Cheeky had formal knowledge, but little common sense social knowledge, it felt plausible for Cheeky to introduce science content or ask scientific questions. Cheeky essentially served the role of pedagogical agent within the games, as well as comic foil in the story. The director also came up with a title for the story, Weightless, which he just to succinctly represent the experience in space, and also to symbolize the experience of two "tweeners" called on to save the world without the help of adults. The lack of adult guidance was as disorienting as the lack of gravity.

As the start of the ADDIE phase "Development," we entered the short story version of Weightless, interspersed with two sample games, into the IMapBook eReader system. The sixth grade class at Hoffner Christian Academy read the eBook and played the two sample computer games. The students felt it was an exciting plot ("Hey, what happens next?") and the games were a fun way to approach solar system content. But the sixth graders said, "This isn't a real book." After a focus group discussion, it came out that it wasn't a real book, not because was computer-based or had computer games, but because the writing was not professional. Whatever qualities the students were used to in commercially published books for sixth graders, obviously a tenured professor of instructional technology, however skilled in academic writing, could not deliver the goods. We hired a young ghostwriter, who was our SME's niece, to write the novel from our scenario. The young ghostwriter, trying to break into the publishing business, was writing two other books for the same sixth grade audience, so it seemed like Kismet, when our SME, Bill, suggested the idea. Our research group read samples of his writing, and decided he had to skills for fiction writing for this audience.

Now we need a real novel

The professor remembers in June of 2012, while attending the GLS conference, standing on the memorial union terrace looking out at Lake Mendota, talking into his cell phone negotiating with the young ghost writer, trying to sound like a tough businessman while gazing out at the ineffable, beautiful blue of the wind-swept waves. In fact, the young writer, all of 25 years old, struck a hard bargain, claiming, "for any less money, I might as well get a summer job slinging hamburgers." The professor had to provide him with a $2,000 down payment to get him to started writing, with the balance due on completion of the novel. However, the money has been well spent, producing a compelling novel. Based on the advice of my lawyer friend, the professor downloaded a copyright agreement from Legal Zoom, and customized it to our needs. The writer worked on Weightless for months during contract discussions, before the professor could actually get the writer to sign the contract. Somewhere along the way, the professor realized he had become a producer.

From July 2012 to February, the ghostwriter, the writer, and the project director and worked as co-authors. The writer wrote installments and emailed them to me. The professor read and provided minor feedback. Mostly it was heady exhilaration to read the scenario, the professor had helped dream up, now in novel form. The writer could cast the rough scenario into vividly imagined real life details and put them into text narrative in way that was compelling and left me constantly wondering what would happen next. The characters seemed like real people, in trouble, who the professor cared about and the professor wanted to know what would happen next to them next, even though, ironically, the professor already roughly knew what would happen since the professor had helped to write the plot. All his life the professor had the fantasy of one day writing the great American novel. With the years of publishing peer-reviewed academic paper, the professor thought he could easily write a novel. Now confronted with the magical process how a real fiction writer creates a novel, the professor realized that his literary dream was pure delusion.

Occasionally, the writer and the professor had some disagreements about structural issues in the novel. A common problem was tension between 100% scientific accuracy (which the professor felt was necessary for the eBook to be credible as science content for schools) and demands of working compelling fiction. The writer informed him that all science fiction has what he youthfully termed "What the F___ moments" where the reader is asked to accept large gaps in logic or believability in the interest of maintaining a compelling narrative flow. As long as the story is compelling and the "What the F___ moments" are not frequent, the reader is happy to overlook the "What the F___ moments."

The professor had two major dis-agreements with the writer. The first was over a point in the story that seemed scientifically unrealistic. We resolved that by consulting via email with the head of the astronomy department at the University of Amsterdam. The second problem was when the writer, in an effort to finish the novel quickly before shifting his attention to law application deadlines, wrote an ending that was rushed and superficial. We resolved that by negotiating that he would first apply to law schools, and then after that write a more developed ending.

Process for designing and creating computer games to go with the novel

With a critical mass of the novel in place, working with the graduate students to designed and create the games was a priority. The writer wrote brief game descriptions at the end of each chapter. During the July and August of 2012, and later in the Fall of 2012, the professor worked a team of graduate students to design the games. The professor would assign the brief description of an idea for a game to one or two students, who would then flesh out the game idea into a more elaborate text description and a storyboard. The team would often suggest revisions. When the game description was approved, the game designer would write a description of the graphics needed for the game, to be sent off to the artist, who an alumni of the course. The artist would then supply rough conceptual sketches. When the group approved, the artist would produce final renderings.

The games in the IMapBook system are defined in a simple xml language, which is then interpreted by the eReader to produce for the game player the game interaction. This system avoids the problem of having to program each new game from scratch. During the summer, the designers wrote xml with a text processor program to create games. The problem was that the xml syntax, while not requiring a formal programming background, was still exacting and required a lot of patience.

At the end of the summer of 2012, we did a formative evaluation with one fourth of the eBook with computer games. Eight students who were struggling readers (transitioning from sixth to seventh grade) in a prep school summer course, read one fourth of the book and played the games. The students took an online questionnaire answering twelve open-ended questions, including about the story (what they liked and what they thought should be improved), about the games (what they liked and what should be improved), and questions about the user interface. The eight students also took part in a focus group. Overwhelmingly, the students found the novel compelling and wanted to read more. They definitely liked having the games in the book, but felt the games could be improved to be more game-like. Based on this formative feedback, the novel was edited in minor ways to improve clarity. The research group also decided that a greater range of types of games was needed.

During the end of the summer, one of the programmers in our research group wrote an authoring tool that allowed non-technical designers to more easily design and create games. While designing games in the Fall of 2012 using the alpha authoring system, a challenge has been that the authoring system and the xml language that it generates are well-suited to creating certain types of games and less suited to creating other types of games. In some cases, the designers really struggled to create the game ideas outlined by the ghostwriter and the director of the project. Because of this, the programmer of the authoring system was asked to create revisions to the authoring system to add other types of games (for instance drag and drop games) that would make game design easier. Another challenge was that our designers were using the authoring system in alpha form before it was debugged. They therefore often found bugs, reported them to the programmer, who then fixed them. This slowed the development process. However these logistic problem are typical of the Development phase of the ADDIE model.

Current status

As of this writing in February of 2013, the novel is complete. The ending is by far the strongest section of the novel. There are computer games for about half the novel. However, the professor feels that some of the games need to be revised, by converting them to drag and drop games. Further, a lot of the chapters with their games exist as separate files, and need to be integrated into one book. In the spring semester, the group is also revising the look and feel of the eReader and creating a beta version of the authoring system. As Implementation and Evaluation phases in the ADDIE model, the group conducted formative evaluation of 60% of the book with games in April of 2013, in a public school with two sixth grade language arts classes, and two science classes. Almost all of the students found the story engrossing, and wanted to read more. They also like the overall concept of web-based books with games. They did feel that the games needed refinement. Intriguingly, three students with learning disabilities (problems with concentration) particularly took to the eBook with games, persevering for a long time, and tutoring actually their normally higher achieving peers on the games.

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Tunnel Tail: Successful game developer-educator collaboration

Francisco Souki, Schell Games, fsouki@schellgames.com

Abstract: This paper describes the development process for Tunnel Tail, a game developed in tandem by a traditional game studio and nonprofit organizations, and released in 2012. Two factors condition the game design: the educational goals and the caveat that the target audience responds negatively to any heavy handed attempts at education through games. By employing their expertise, the companies are able to come up with a solution that satisfies the educational and game design goals. This paper explains the approach taken, why it worked for the parties involved, the risks associated with it and when and how to adopt a similar approach.

Introduction

In Summer 2012 Schell Games, in collaboration with the BEST Foundation and Drug Strategies, released Tunnel Tail, a mobile video game which had the goal of introducing teens to situations in which they might be tempted to try substances such as alcohol, drugs and tobacco and providing them with the right tools to recognize and navigate these situations. This paper describes the process taken throughout the development period to ensure that the game satisfied the educational goals set by the BEST Foundation and Drug Strategies as well as the game design goals set by Schell Games.

Furthermore, this paper explains the design methods utilized by both companies to ensure that both sets of goals were met, explores the takeaways derived from the experience and how they could be applied on similar projects, describes the measurement strategy for educational impact and identifies portions of the process that could have been better executed.

Defining the game

The first step toward the development of Tunnel Tail addressed the definition of the platform and target audience. The game would be developed for the iPhone and Android platforms, and would target players between 11 and 13 years of age. Early focus testing motivated the team to create an edgy setting for the game, in which the main characters were to be sentient mice who live and coexist with humans in the world as we know it today. These mice confront beings known as the Controllers. The player's role in the game is that of a human being who is asked to help lead a tribe of mice against the Controllers. As the game progresses, the player earns the trust of new recruits for their tribe.

***Figure 1*: The player leads a team of mice**

Messaging caveat

In early focus testing, players had a strong negative reaction to the notion of the game referring literally to substances such as drugs and alcohol. This led the team to make the decision of not addressing these substances directly at any point in the game, but rather with metaphors. As a result, the game's ability to meet its messaging goals relies heavily on its game mechanics and their ability to reinforce the different metaphors in the story.

Stating the problem

After the initial concept and focus testing phases, it became clear that the game should satisfy two goals: the educational goals and the game design goals. As such, the first order of business became to draft a list of clear goals that the game should aim for. These goals would become the guiding compass of the game development process, staying always at the core of the decision making.

The project goals were defined as follows:

- First and foremost, create a fun, engaging experience that audiences want to play.
- Introduce players to situations where they may feel pressured, and display methods of dealing with them.
- Introduce the internal / external pressures that can influence decision making.
- Show that players don't need to give in to negative pressures to be cool.
- Engage the player without preaching or speaking down to them.
- Create a mechanism for showing positive peer support.
- Provide a skill recognition and actualization activity.
- Normative education: emphasize that the majority do not use substances, nor do they find it cool.

A common language

A key aspect in developing these goals was stating them in a way that was satisfying and understandable for all parties involved. As such, the goals tackle game design and educational missions at the same time and hint at ways in which these aspects might be connected. For example, a goal like "engage the player without preaching or speaking down to them" suggests that the game must be engaging and that the game writing must be carefully curated.

Methodology

To work around our messaging caveat, Tunnel Tail relies on metaphor, game mechanics that can carry a message, and other subtle indicators of the points that it aims to educate on. As such, the messaging must be explicit and clear enough so that the players get something out of it, but subtle enough that it doesn't feel obviously like a game trying to teach them. Many of the situations and mechanics in the game are intended to provide the player with a metaphorical layer that they can overlay on their lives, providing a toolbox of sorts in their subconscious which they can call upon when they have to deal with temptation and standing up to pressure.

This methodology can be tied to the concept of *incidental learning*, which is to say the type of learning which is unplanned or even unintentional. The player should approach the game of their own volition, drawn by its properties as a game. The learning should then follow naturally, as a result of the player experiencing the game.

Custom fit

The methodology described above plays well with the goals set at the beginning of the project and fits the particular case of our game. However, this is not to say that it is the right solution for every educational game project. The following factors played a key role in developing the above methodology:

1. The BEST Foundation's and Drug Strategies' philosophy: It is in line with their vision to provide kids with the right tools to make informed decisions and navigate social pressure. This plays well with an incidental

learning approach.

2. Due to the nature of our educational content and our target audience, dealing directly with the substance abuse subject would scare the players away.

3. It is in the nature of Schell Games to adopt a fun-first and transformational approach. That is to say, we are partial to designing game mechanics as vehicles for educational content, rather than letting the content carry the educational weight.

4. The time scheduled for production, close to a year, was enough to explore and refine accurate transformational game mechanics.

Initial wrong approach

During early development, several core concepts were proposed to bear the weight of the educational theme. Initially, the concept of "will" was chosen to communicate the notion that teenagers ultimately have a choice when becoming involved in pressure situations. In the game, the mice characters would have a measurable amount of will, which would determine their strength and likelihood to give in to temptation.

The team quickly realized the problem with this approach, as we did not want the game's message to communicate that being weak-willed leads to trying substances. Rather, the ability to choose comes from retaining control: control of one's self, actions and environment.

Teenagers deal with struggles of control in their daily life. Their bodies, their time, their friends all seem like they could spin out of their control at any time. Additionally, they experience a plethora of emotions daily that can easily overwhelm them, should they lose control. As a result, the team decided to pursue the central theme of Control, especially when framed in the context of Influence.

Transformational game mechanics

The final game plays like a traditional role-playing game and uses a mix of innovative mechanics and traditional mechanics of the genre to deliver its educational content. Tunnel Tail's transformational mechanics include:

1. **Story**. The game's theme of Control is explored throughout a story that focuses on flawed characters, how they come to terms with their shortcomings and support each other. The story makes no mention of substances, but includes the mention of a mysterious substance called "The Stuff".

2. **Combat**. The game builds on combat encounters as metaphors for real-world situations in which the players might be pressured into doing something they are not comfortable doing.

3. **Pressure**. The core element of the combat system, the pressure mechanic provides a way to expose the player to different types of social pressure and different methods to deal with it.

4. **Recruiting new members**. As the player progresses through the story, they help and support new mice as they join their team.

5. **Conditions**. The main negative effect of losing battles, conditions are based on identified causes and consequences of substance use and prevent a mouse from going to battle. Players can help their mice work through their troubles and get them back in action.

6. **Cooperative multiplayer**. Creates a positive peer group for the player.

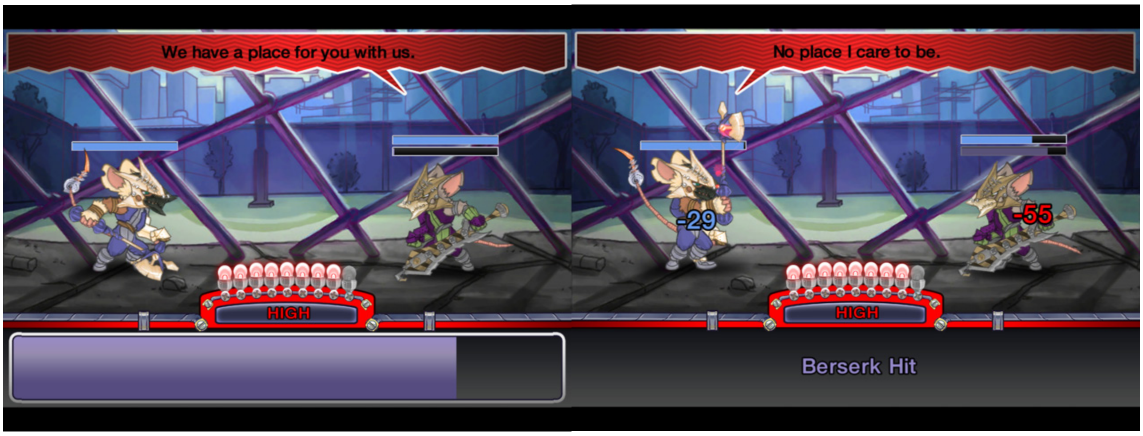

***Figure 2*: Using combat as a metaphor for pressure situations**

***Figure 3*: Using combat as a metaphor for pressure situations**

All in all, the relationship between mechanics and goals is bidirectional. The game was designed to meet the broader initial goals, but opportunities were seized during the development process to address smaller but equally relevant goals via the use of game mechanics.

The design of the combat system is central to both the game experience and the messaging embedded in the game, becoming the heart of the experience. It seems natural that the biggest part of the messaging be carried forth by the main game system. The peripheral systems support the central design and the central theme.

In the periphery, Missions address bit-by-bit learning by equating it to sporadic gameplay. Conditions help drive home the fact that there are real world consequences to our decisions and that making the wrong choice is not the end of the world - rather, there is help for those who seek it. The game story guides the player through different high pressure situations by placing them deep inside different conflicts that address real world problems; and at the same time it puts the player in contact with characters that have had a hard time dealing with everyday pressures. Finally, the Multiplayer system reminds the player that they are not alone in this fight.

Measuring the seemingly immeasurable

The most obvious drawback of this approach is the difficulty to measure the impact the game is having on the players. Are the kids learning? Is it making any difference?

The approach taken by the development team, and a luxury not all teams are able to afford, was that of focusing on making a fun game curated by educational experts. In that regard, getting the kids exposed to the right content was considered to be a big educational win.

Exposure, however, is not enough to justify a project of this magnitude. As such, the team designed a set of game metrics that we felt would provide a valuable glimpse into the type of experience the players were having. These metrics focused on the transformational mechanics mentioned above, and included:

1. Amount of time players spend with the game.
2. How good players are at the game.
3. The players' performance at the game and how it varies over time.
4. Are the players getting exposed to the right content in the right context.

In addition to this, we recorded traditional mobile game metrics to work on increasing our player retention.

Still, these metrics do not provide a definitive answer. The team is currently moving forward toward a more final verdict by way of organizing a study to measure whether the content is being absorbed by the kids. To that end, Schell Games has made an effort to poll playtesters with the goal of assessing the impact of the content, with satisfying results and The BEST Foundation and Drug Strategies are currently working on a formal study to assess whether players develop skills for handling pressuring situations after playing Tunnel Tail.

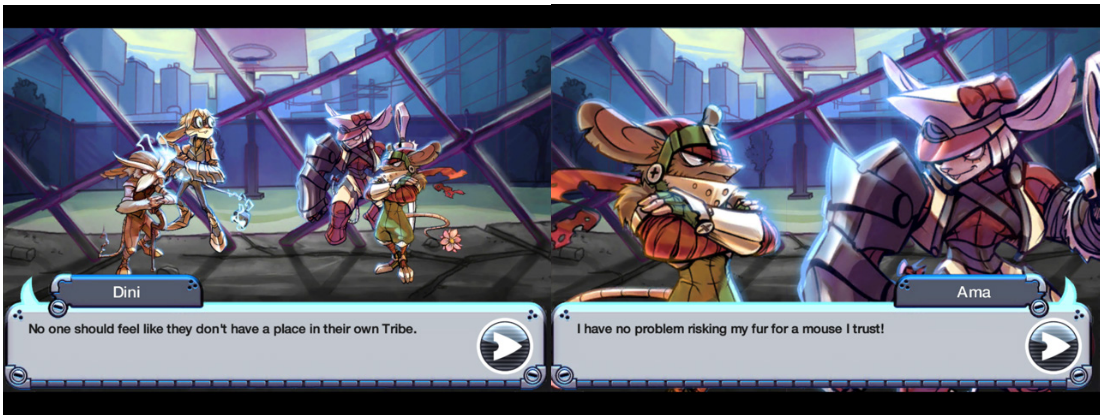

Figure 4: **The story of the game supports the educational theme**

Dangers of collaboration

This approach is not without its dangers. The main risk we identified lies in the amount of people involved in decision-making. In our quest to involve the best of the best in the development process we contracted educational experts and content creators to help craft a great experience. The balance of their involvement is surely positive, but it was a challenge to stop the process from getting muddled by the overhead costs of having too many cooks in the kitchen.

The team became increasingly better at fomenting decentralization of approvals, such that individual workgroups became responsible for collaborating on specific tasks. This requires constant attention from the managers and leaders to ensure that the information is flowing in the right ways and that all groups have what they need to work.

Because of the large amount of content in Tunnel Tail, the approvals process became a bottleneck toward the end of the project, leading to specific cases of less-than-excellent content being released in initial versions of the game. Internal reviews and community involvement led the team to patch the game promptly with content improvements.

Importance of working together

All in all, we identified tremendous value in assembling a team of game development experts and educational experts to tackle this problem. The expertise of both companies shines through in the final gameplay and the released game is testament to the validity of the process.

The most important factor during the development process was the constant communication in the form of weekly calls between the two companies and regular in-person meetings to study the progress of the game and discuss next steps and solutions to arising problems. Both companies kept open ears to ideas and acknowledged the expertise of their counterpart.

Conclusion

The aim of this paper is to show a practical example of how the process of developing transformational game mechanics between game development experts and educational experts provided successful results for the development of the mobile game Tunnel Tail, developed by Schell Games and the BEST Foundation in collaboration with Drug Strategies.

By providing a description of the development process, the key decisions made while making this game and the end result, the aim is to prove that the process is a viable route for teams in a similar situation. In addition, by providing insight into the challenges and successes of the development cycle, the goal is to give an objective look at all aspects of this process.

The hope is that the fact that the development team for the project is comprised of both a traditional game development studio and a nonprofit organization serve as inspiration for other organizations and studios to seek similar partnerships.

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Acknowledgements

An earlier version of this paper was presented at the 2012 Games+Learning+Society conference. The previous paper explored the specific ways in which the game's design met the educational goals, whereas this paper focuses on the development process itself. Since the game had not been released at the time of the writing of the previous paper, this paper also focuses on the release process and lessons learned from releasing the game.

There Is A Reason They Are Called Games: The Affordances And Constraints Of iCivics Games For Democratic Education

Jeremy Stoddard, Christine Nemacheck, & Angela Banks, The College of William & Mary

Abstract: Videogames, along with social media and online learning environments (e.g., MOOCs), are the most recent technological advancements viewed as an educational panacea and a force for democracy. However, as with previous technologies (e.g., educational radio, film), these mediums have particular affordances and constraints as educational environments and tools for democratic education. This paper presents results from a study of the content, design, and potential for four iCivics games (e.g., Do I Have a Right) to meet the goals of democratic education. Specifically, we focus on the design of the games as an educational context, the accuracy of the content, and if they present best case, fair hearing, of competing points of view on issues deemed controversial in contemporary society. We hope this study helps to continue the conversation between democratic educators, game designers, and educational researchers.

Introduction

[Statue of Liberty] You know what we do with boat thieves in these parts…?
That's right: WE DON'T LET THEM INTO THE COUNTRY!
Get rid of this jerk! Oh, and call the police. (*Immigration Nation*, iCivics.org)

I received this feedback from the Statue of Liberty as feedback agent while playing the iCivics game *Immigration Nation* after letting a "boat thief" into the country. From a design perspective, this feedback is supposed to help me learn the rules of US citizenship and immigration policy through an iterative feedback and action loop emphasizing the correct answers. Visually, this means I click on a ship to learn about the passenger and then need to decide if he or she should be allowed to enter the harbor based on claims to citizenship.

Later in the same game, I choose to allow a character named Sivaji to come into the country with permission to work – as he claimed "I'm a fantastic software programmer from India. I've been hired to program for an American company that specializes in health care software." This time the Statue of Liberty tells me that I have done well – "Great! I'm sure Sivaji will do a lot of good work. After a few years in the country, he may be eligible to become a citizen!"

This game is obviously designed using content from a middle school civics curriculum with the objective of helping young people learn about current immigration policies at the rule or conceptual level. The fictional cases used as concept examples are designed to hopefully encourage players to continue to play, win, and thus master the content. However, as game designers build these cases (the content) and the rules of the game, they also shape the nature of the possible narrative arcs that a player will construct through playing, and thus the "ideological world" (Squire, 2006) of the game. The construction of these designed experiences also shapes how young players will view their role as citizens and their views on the world. It is important, then, to also consider how these games will help students connect the individual actions in the game to larger ethical, political, and controversial issues in society (Raphael, Bachen, Lynn, Baldwin-Philippi, and McKee, 2009).

In this study we examine how four iCivics games are designed to engage young people as learners and as citizens-in-training. In this first stage of the study, we are attempting to answer the following question: *What are the affordances and constraints of iCivics for democratic education?*

iCivics

The brainchild of former US Supreme Court Justice Sandra Day O'Connor, iCivics (formerly known as "Our Court" – www.icivics.org) is her answer to the perceived lack of civic knowledge and youth participation in the US. Based at Georgetown Law School and in partnership with Filament Games and faculty from Arizona State University, iCivics has developed over fifteen games for use in and out of school and accompanying curriculum for teachers to use in their classes. These games are designed from the ground up for use in education, utilize child-friendly graphics and catchy music, feature easy gameplay with heavily scaffolding, and have a gameplay and narrative structure that can make the games playable within a school schedule. The games focus on topics such as constitutional rights, the roles of the different branches of the government, and specific issues such as immigration policy and fiscal policy.

Games and Gaming to Learn

Enthusiasm for the use of video games in education is far from new. From the ubiquitous Turtle mathematics games to the oft-criticized Oregon Trail, beliefs in educational gaming are decades old. Over the past decade, there has been a more concerted effort to begin to look at the learning potential for games and gaming beyond just motivation. These include investigations into how literacies may be developed through gaming (Gee, 2003), how gaming and simulations that model professional or disciplinary models can be used to teach in areas such as the STEM disciplines (science, technology, engineering & mathematics) (e.g., Shaffer, 2004; Shaffer & Gee, 2006; Poole, Berson, & Levine, 2008), and work that examines the use of commercial games in learning about subjects such as history and geography (e.g., Squire, 2005). Raphael, et al., (2009) present a framework for research and design of games for civic education, and raise several central issues, including the importance of aligning games with civic content as well as citizenship-related skills and a focus on action that can be applied outside of the game. Most of these studies, however, have not been conducted in regular classroom contexts or within some of the constraints of a tightly standardized curriculum that is often burdened by high stakes testing

Research into the iCivics games is limited. In a recently released study by CIRCLE (The Center for Information and Research on Civic Learning and Engagement), Kawashima-Ginsberg (2012) found that the iCivics game *Drafting Board*, designed to help young people develop skills in constructing argumentative essays related to issues such as the electoral college and doing community service, had a significant positive effect on participants in an experimental study. Early results from additional studies conducted by a research group at Baylor University (Blevins, LeCompte, Wells, Moore, and Rodgers, 2012) found positive effects in middle school participants in both knowledge of basic civics facts and concepts and in areas such as motivation as a result of playing selected games. Both of these studies focus on explicit outcomes of iCivics: skill development in evidence and argumentative essays, acquisition of factual knowledge, and dispositions such as motivations to learn. These studies do not look at the role of the games in presenting particular perspectives and narratives on what it means to be a citizen or the development in other types of citizenship related skills. In addition, despite these positive results from a project like iCivics, there is reason to be skeptical. There have been many technologies that preceded games that have been viewed as the great panacea for education (Cuban, 1986) and the solution for problems like the digital divide and educational inequity (Cuban, 2001; Margolis, 2008). Of course, this lack of adoption of technologies, or lack of effective adoption, is in part due to the structures of schooling and training of teachers.

In addition to questioning the educational value of technology, there are also questions raised about the political and ideological messages that may be constructed within games (deLeon, 2008) or the narratives players may construct in the ideological worlds of the games (Squire, 2006). Raphael, et al., (2009) note the importance of having students reflect on how the design and production of the game reflects particular views. The research on iCivics described above, and the iCivics project overall, provides much optimism for these games to engage young people in civic education. In this study we analyze the affordances and constraints of four iCivics games for the potential for democratic education. In particular, we focus on the design for engaging students, the accuracy of the content in the games, the nature of thinking and intellectual work required in gameplay, and the ideological messages in the narrative arcs constructed through the games. We use a framework from democratic education as our lens for analysis (described below).

Analysis of iCivics

Our research team is comprised of three primary researchers, one who studies the relationship between media and democratic education, a political scientist with a background in the Supreme Court and constitution, and a law scholar with a background in human rights and immigration. We also have eight research assistants who are either law students or upper class undergraduate government majors who have expertise in the content areas of the games. We selected four games that reflect prominent contemporary issues in American politics and society: *Do I Have a Right?*, *Executive Command*, *Immigration Nation*, and *People's Pie*. These games all have specific outcomes in terms of content that appears in most state standards for government, economics, or civics. Two of these games involved policies that are currently either hotly contested or include divergent interpretations of policy or the constitution (e.g., Do I Have a Right?, Immigration Nation) or include policies of the executive branch that are often ideological in nature (e.g., Executive Command, People's Pie). One of the questions we asked in the analysis is whether or not these games, and especially the ones that should realistically include different political viewpoints, include a "best case, fair hearing, of competing points of view" (Kelly, 1986).

Democratic Citizenship Framework

The primary focus of our study is to understand how these games may be a medium for democratic education. There is some disagreement about what democratic education, or its alter egos of civic education or citizenship education, should include or what matters most in terms of outcomes. For this study we focused on ideas drawn from the Civic Mission of Schools (Gould, 2011) report and the work of scholars from deliberative democracy and more action or justice-oriented democratic citizenship (e.g, Hess, 2009; Parker, 2003; Westheimer & Kahne, 2004). These include goals in civic education related to knowledge of civic content, the ability to discuss controversial issues, and the power of simulating civic related roles, from local activist to a legislator or president.

In order to answer our first research question, we were concerned with how the games were designed to engage young citizens, regardless of differing ability, culture, or class, for example. We were also interested in terms of how the games were scaffolded (Brush and Saye, 2002) and how students were positioned or placed in roles related to civic engagement. Second, we were interested in the content of the game and what types of thinking the game would require. That is, in addition to making sure the content in the games was as accurate as possible, we were also interested in the types of intellectual work the game required. Does the player engage in authentic intellectual work (Newmann, King, and Carmichael, 2007) and require higher order types of intellectual thinking , or does it prepare students to be able to take thoughtful civic action outside of school?

Further, we know that certain types of thinking are particularly important for democratic citizenship: being able to inquire about problems or questions for which there are multiple competing answers, being able to take a position and use evidence to warrant that position, and being able to discuss and deliberate controversial issues (Parker, 2003; Hess, 2009). Therefore, we examined whether or not the games included open or closed issues or questions (Hess, 2009), and whether or not issues related to policy that have multiple and competing legitimate positions in society were present (Kelly, 1986). The analysis of the nature of issues presented, as being open or closed, and the inclusion of competing perspectives, helps to provide us with a sense of the "ideological worlds" constructed through the designed experience of the iCivics games (Squire, 2006).

Methods

The four iCivics games selected for analysis all have themes and objectives related to important contemporary topics or issues: Do I Have a Right? (constitutional rights, including free speech and the right to bear arms) Executive Command (executive power / policy decision making), Immigration Nation (immigration policy, routes to citizenship), and People's Pie (fiscal policy, debt, entitlements).

Two of the student research assistants played each of the four games multiple times to discover the likely possible situations, consequences, and feedback responses on computers equipped with *Screenflow,* a program that allows for recording the gameplay and conversations between the two research assistants. They were instructed to also follow a "think out loud" protocol, explaining what they were doing and why they were making particular decisions. These initial comments provide a sense of the emotional or affective reaction to the game as well as an initial round of analysis in terms of reaction to the games, the nature of the intellectual work and what they are experiencing, as well as a way to understand the nature of the gameplay. The research assistants then transcribed the screen text feedback into a sort of script from their hour of play to use for coding.

Below we present some initial themes that have emerged from our analysis, using the emergent coding scheme dimensions of: 1) game design and scaffolding (e.g., Saye and Brush, 2002); 2) the factual accuracy and nature of the content in the game; 3) the nature of the intellectual work required and whether issues/problems are presented as open/closed; 4) the perspectives included and whether or not the player is pushed toward a "correct" answer for open issues as a result of the feedback scaffolding and the nature of the game design (the analysis of the ideological world of the game). Additional analysis will also look at the curriculum intended to be used with the games and other materials on the iCivics site.

Initial Results

Below we present a few initial themes that have emerged from the study. These focus on the affordances, such as the explicit design of the games for use in schools and ties to standards and civics concepts, to the constraints, which include a lack of emphasis on a more dynamic "non textbook" civic content and no clear applications to civic action for players.

Affordances and Constraints of iCivics Games

Compared to the educational games of old, or even many of the simplistic Flash games available online today, these games are designed to engage young people and to help them quickly acclimate to the game environment. The iCivics games are notable for the small bobble head like characters, catchy and upbeat musical soundtrack, and designs that emphasize active participation with heavily scaffolded gaming models. The games are designed to be used within the limits of classroom structures, the fifty-minute period, or outside of the classroom with little additional support needed to learn the basic game play. When entering a game for the first time, pop up windows explain the components of the game and basic actions to get the player started. This kind of explicit "hard" scaffolding allows for the player to quickly get into the game and learn the gameplay without the kinds of leveling that often take place in a commercial game.

The first level or task in these games generally emphasizes learning the basic game play and introduces the main conceptual goal for the content or skill objective at the heart of the game. All of these games are designed to get the player to learn the critical attributes of the designed concepts and apply them. For example, Do I Have a Right? focuses on the acquisition of conceptual understanding of the constitutional rights of individuals, such as the rights of free speech or equal opportunity, including the "freedom of expression" in the First Amendment (see Figure 1 below). The player is introduced to the attributes or definition of the concept through the partners that s/he selects for the firm, Chuck Freepress in the example below. The player is then asked to apply this knowledge by determining whether or not potential clients have a right, and if there is a partner who is skilled in that particular conceptual area. Subsequent tasks or levels expand on that content by adding complexity such as additional partners and clients, and emphasize practice of the tasks with a feedback loop that corrects incorrect choices or decisions the player makes. This feedback, or scaffolding, pushes players toward the correct answers that will help him or her to pass the level or successfully complete the task and therefore "win." It also makes the games more accessible to all levels of students.

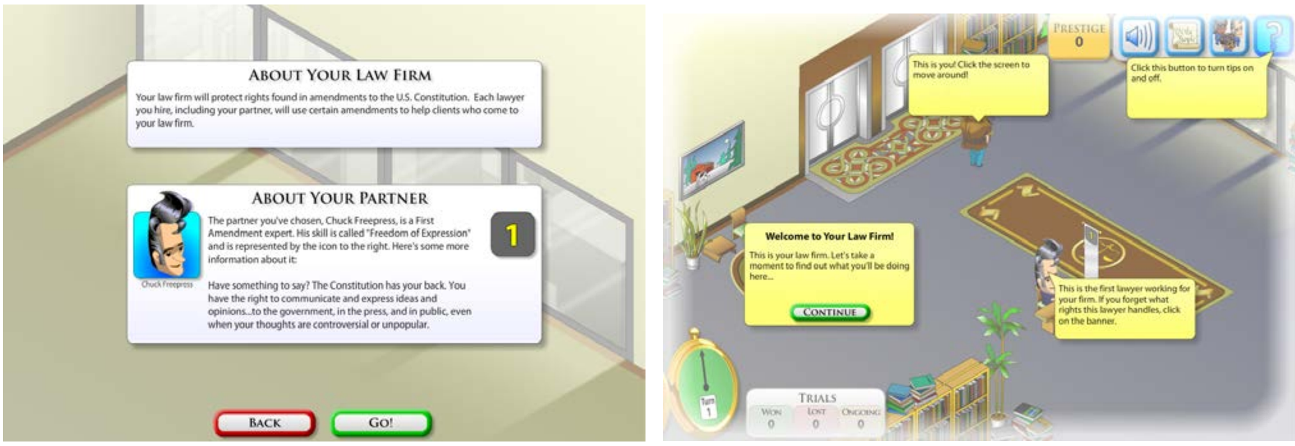

Figure 1: Screen Shots Illustrating Conceptual Goals and Scaffolding in Do I Have a Right?

One aspect of the games that emerged quickly, in addition to the concept based design, was the affective reaction that was intended from playing some of the games. For example, the research assistants who played Executive Command were noticeably stressed trying to juggle all of the demands of their avatar president, and those who played People's Pie talked about their frustration with having to borrow money and how much they empathized with frustration felt by legislators related to budget issues. These affective elements are an affordance that also aligns with the goal of simulating civic related roles identified in the Civic Mission of Schools report.

One of the major constraints of these games is that they are largely text heavy, and may present difficulties for students who struggle with reading or for whom English is not their native language. However, given the parameters of this study we cannot make any assertions as to the reality of these challenges. There are also limits to developing conceptual understanding in civic related concepts when only applied to abstract or even absurd examples in the games versus more realistic or contemporary examples. For example, in People's Pie students are asked to weigh funding programs such as a "sniffing cat" program for Homeland Security instead of more realistic programs where players may have to make more difficult decisions based on what they think is important to fund.

The engaging aspect to these games is especially important when compared to other educational games or even the first iCivics game, *Supreme Decision*, which was made by a different game designer and was also a strategy game but much slower and even more text heavy, and less well scaffolded. These games are attempting to be engaging and appealing for young people who may or may not spend hours a day playing games.

Games and Democratic Education

There is no doubt that the games are designed to be both engaging and in alignment with traditional civics content, especially large key concepts. How well the games meet other goals of democratic education is more debatable. Two of the games include largely closed issues (Do I have a Right?, Immigration Nation). These games are designed to help students learn the "correct" answer related to concepts surrounding constitutional rights and immigration law, respectively. However, does taking on the role of an immigration agent help the player to learn what it means to be a citizen? Does it present the many complexities in immigration policy and the debates around it? In this case the game is designed for a young audience and focuses largely on the more explicit policies, such as the example in the opening illustrates, that wanted criminals will not be allowed citizenship, and immigrants who have expertise needed for the US economy, will. This tension between explicit knowledge and deliberative democratic education, of course, reflects the larger tension in the field of civic education and the multiple and competing perspectives on what should be taught and how it should be taught. Further, although the language used is meant to be engaging, is calling the "boat thief" a "jerk" the type of modeling that we want for citizens?

For the two more open games, Executive Command and People's Pie, a different tension emerges in game design. For both of these games, winning is measured by the amount of citizen support or satisfaction that the player's decisions create. The goals of the game are to help students to recognize the various roles of the executive branch and the tensions involved in making budgetary decisions at the Federal Level. Given the fictional world of the games, however, also again involves simplifying the issues and focusing more on figuring out how to win the game than the ramifications for cutting spending on entitlements (People's Pie) or for advocating a stricter foreign policy role (Executive Command). Here the tension that emerges is the one between the goal of the game (winning through citizen satisfaction) and the goal of democratic education. Again, this is an area for continued dialogue between game designers and democratic educators.

This seemingly arbitrary reward system for "winning" in these games did not seem to be tied to the specific concepts or issues, but more so for showing that you "won" by learning the rules. This is problematic because although these games reflect real contemporary issues, the content and rules are based on "textbook" versions and not more dynamic or realistic examples. For example, every scenario played in Executive Command includes a war with a fictional country. However, the model is based on a war in the constitutional sense, with formal declarations, and not the kind of conflicts the US has been involved in since World War II. The game also does not allow you to avoid conflict or settle the issue without being encouraged (or forced) to win by the use of military force. This tension between actively engaging in "textbook" civics concepts, in this case knowing that the executive is commander in chief over a military that includes a navy, army, etc., versus using examples drawn from contemporary or more dynamic examples of these issues reflects a larger tension in the field of civic education as a whole.

Ideological Complications

In addition to the tensions that are illustrated above, and that reflect larger tensions in the field of social studies or democratic education, there are also emerging themes related to the ideological worlds of the two open games in particular. It is easy given the interactive nature and design of these games to see them as fun, engaging, and neutral. However, it is important to remember that there are people behind the designs of the game; people with political views and values and with different goals and objectives. They also have ideas about what it means to learn, how people best learn, and what it means to be a citizen. In the case of these games, it may be particular strategies and outcomes that will help the player win the game. Will they win by applying a strategy of low taxes and spending? Or will citizens be more satisfied by higher corporate tax rates and robust entitlements? Is it better that we have a president with a strong hawkish foreign policy or one that focuses on domestic issues?

However, for the most part the player is not faced with decisions based on a fair hearing of competing points of view. Instead, there appears to be a "right" answer the game is designed to push the player toward. This is done through the examples provided during activities like giving a speech to Congress on a policy area that the player has selected. For example, if you select "security" as an administrative priority in Executive Command and give a speech to a joint session of congress to promote the issue, you are given two choices at each stage of your "speech" to try to get a high rating. The options you get, however, are not one of engaging through diplomacy versus using the threat of military force, or an isolationist versus interventionist stance toward a nation overseas that asks us to intervene. Instead one legitimate perspective on the issue is given alongside a rather ridiculous answer intended to be "wrong." In the case in Figure 2, a point about shutting down all of the fire and police stations so they can go on vacation is juxtaposed to one about spending all day and night guarding the country from terrorism. These options do not engage the player in weighing legitimate competing options and instead push a player toward a particular ideologically driven view on foreign and domestic security.

Figure 2: Examples of Policy Options in Executive Command

Again, the tension between game design and democratic education emerges in regards to designing a game to teach content for which there is an agreed upon correct answer versus areas within the field where we want students to deliberate and make informed decisions from multiple and competing legitimate perspectives.

Potential Implications

These are not simple "drill and kill" games similar to those used in classrooms of the past. These games attempt to engage kids at a conceptual level using "mock" situations. There are many great affordances to the iCivics games. On the other hand, the game design uses abstract and sometimes almost absurd situations and content to help students develop and apply their understanding of these concepts. This tension raises questions about how suitable current game design is, at least as illustrated in these games, for democratic education – especially a version of democratic education that envisions young people deliberating and making informed decisions on complex issues. There are limits on what can be done in a game designed to be easy to access and use, but one of the goals of using a game with the affordances of the iCivics games should be taking advantage of more dynamic and contemporary issues and data.

Perhaps these games are a first step to at least helping young people develop the concepts that can be applied to real situations later. Even this, however, will likely require a role for a teacher or parent to help them reflect upon, and apply, the concepts that they learn in the game to those they represent in the world. Will students who are able to tell you the definition of the First Amendment be able to understand the ruling of the US Supreme Court in Johnson v. Texas (1989) case on flag burning? Will students be able to apply their understanding of an accurate role of the executive in times of war based on their Executive Command scenarios that are devoid of the War Powers Act? The metaphorical, conceptual, or abstract knowledge students may gain from playing the games needs to include an understanding of how it applies to the world outside of the diegesis of the game. It is with these goals in mind that game designers, democratic educators, and researchers should work together to take advantage of the many affordances evident in the iCivics games to more strongly work toward the goals of democratic education.

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xWe Can't Just Go Shooting Asteroids Like Space Cowboys: The Role of Narrative in Immersive, Interactive Simulations for Learning

Vanessa Svihla, Nicholas Kvam, Jeffrey Bowles, Joe Kniss, University of New Mexico,
vsvihla@unm.edu, ndkvam@unm.edu, jeff71@unm.edu, joe.kniss@gmail.com
Matthew Dahlgren, BASIS Phoenix, matthew.dahlgren@basisphoenix.org

Abstract: The purpose of this study is to explore how merging narrative, role-play, and immersive, interactive technology can support learners to participate in designerly STEM practices (e.g., posing questions, designing investigations, modeling data). Set in university pre-service teacher education courses, we contrast two problem-based units incorporating immersive, interactive projection. Elementary pre-service teachers (n=9) completed a three-day unit on arithmetic and geometric sequences embedded in a narrative of defending the Earth by testing a top-secret weapon to destroy asteroids. Secondary science pre-service teachers (n=8) completed a three-day unit that included an immersive simulation of the greenhouse effect, but lacked a narrative context. This study reports qualitative analysis of video-recorded interactions, examining how students engaged and participated. In the former, the narrative context pervaded interactions, and invited participation from students who rarely participated. In the latter, the students engaged as scientists, surfacing numerous questions and investigations. Students engaged mathematically/ scientifically within the immersive environment.

Standing on the navigation platform in the center of the capsule, a young woman leans forward, plunging her crew into a dizzying dive through space. "On your left!" shouts one of her crew- an asteroid-spotter. The gunner deftly fires the B612 Asteroid Splitter, and the asteroid splits into 3 pieces, each big enough to wipe out life on Earth. The captain leans forward, this time making only minor course corrections so her gunner can finish the job, dividing the remaining pieces repeatedly into three pieces. "Tech, give me a report. How many asteroids do we have out there now and how many are still planet-killers?" she asks. "On our first scan, we had 20. After one strike of the B612, we had 22. After three more strikes, we had 28. Now we have 262, but only 19 are big enough to pose a threat." "On your right! Watch out!" shouts one of the spotters. "Wait," says Ignacio, one of the mission recorders, "So would there be a formula? Would? Be like, uh, the number of asteroids minus … minus one when it splits into three?" With the simulation still playing on the dome surrounding them, the teacher encourages his students to discuss, "Can anybody help him out? What do you guys think the formula for this thing should be?"

Introduction

Whereas many technologies place a screen between learners, immersive technology of the type we investigate creates a surround that engulfs learners (Figure 1); the addition of multi-user interactivity allows them to navigate and explore. We explore how immersive, interactive technology might support learning of inquiry practices, such as posing questions, designing investigations, and modeling data. School STEM has long been criticized for not reflecting professional practice (e.g., Rudolph, 2005). New standards focus on STEM practices (Common Core State Standards Initiative, 2010; National Research Council, 2012). STEM professionals engage in *designerly* practices (Cross, 2001), meaning they generate their own questions and design investigations involving variables they select, but in schools, the questions, procedures, and variables are generally provided. Even inquiry activities created by researchers interested in studying how students learn science seldom ask students to generate their own questions or design investigations (Chinn & Malhotra, 2002). Students seldom have opportunities to participate in *designerly* practices (e.g*., posing questions, designing investigations, modeling data*).

As our team works to design low-cost, immersive, interactive projection kits for classroom use, we explore the affordances of this technology; we consider dimensions that provoke authentic context, including how role-play and narrative support students to engage in designerly aspects of STEM practice. We investigate a digital dome-- a type of *panoramic display* in which the learner can look around at "a wide field of view look into the virtual world, seeing many things at once" (Jacobson, 2012, para 10). We focus on two types of *presence*: *sensory* (feeling present in the virtual world (Jacobson, 2012; Slater, 2009)), and *narrative* (feeling present in a story, with the ability to shape it (Jacobson, 2012)). We explore *multi-user interactivity* (multiple learners can interact with the display simultaneously) and role-play. By combining these aspects, we hope to provoke *consequential engagement* – that is, we want students to recognize "the usefulness and impact of disciplinary content" (Gresalfi & Barab, 2011, p. 302)but not necessarily with an understanding
of why one is performing such procedures.
 Conceptual engagement involves more
than plugging numbers into an equation, but additionally
involves understanding why an equation
works the way it does. In contrast, consequential
and critical engagement concern the coordination
of content, contexts, and learner decisionmaking. Consequential engagement involves
recognizing the usefulness and impact of disciplinary
content; being able to connect particular
solutions to particular outcomes."302{Gresalfi, 2011 #5202}
</research-notes></record></Cite></EndNote>. This paper contrasts two enactments, one of which incorporated narrative, to explore the ways designerly practices-- posing questions, designing investigations, modeling data—were or were not supported.

Figure 1: Similar to a small planetarium, our 15-ft diameter dome can accommodate 12 learners. Six projectors powered by one Mac Pro allow for multi-user interactivity. Here, DomeStroids is controlled with a WiiMote and pressure sensors in a skateboard interface.

Immersive, Interactive display

Immersive displays –such as our dome-- allow for exploration of three dimensional spaces and have been shown to support factual and conceptual learning (e.g., Lantz, 2011). Comparisons of display types have found advantages for immersive displays over standard desktop displays for factual recall and conceptual learning of architecture (Jacobson, 2010) and understanding of the chemical reactions (Limniou, Roberts, & Papadopoulos, 2008). Likewise, learning about Mayan culture and astronomy was significantly higher when viewed in a dome system, compared to theater screens (Heimlich, Sickler, Yocco, & Storksdieck, 2010). *Interactivity* may be an important key for creating sensory and narrative presence, and in turn supporting learning (Dondlinger, 2007). The addition of multi-user interactivity opens up new possibilities for learning (Emmart, 2005; Wyatt, 2005).

Sensory Presence

Sensory presence enhances engagement, which in turn leads to greater learning (Fraser et al., 2012). Immersive displays tend to provide a strong sense of being present in the virtual—as opposed to physical—world (Bailenson et al., 2008). Virtual environments allow learners to feel more present (Kafai, 2006). Even online, interactive environments can evoke a sense of presence (Lessiter, Freeman, Keogh, & Davidoff, 2001). Presence has been measured via survey (Heeter, 1992; Witmer & Singer, 1998), physiological measures (Meehan, Insko, Whitton, & Brooks Jr, 2002), and behavioral measures (Bailenson, Blascovich, Beall, & Loomis, 2003). Based on research on psychological processes, it is not "paramount to create the most realistic or captivating experience regarding immersion and presence" when learning—as opposed to entertainment—is the goal (Schnall, Hedge, & Weaver, 2012, p. 11).

Narrative Presence and Role Play

Evidence from neurobiology, cognitive psychology, and research on memory demonstrates that narrative supports learning by providing coherence and context (Hazel, 2008), allowing learners to construct meaning (Bruner, 1991). Narrative provides a motivating context for problem solving (Dickey, 2006). *Narrative presence* supports learning by providing a situated experience (Dede, 2009). Prior knowledge and culture interact with the degree to which learners feel present in the narrative and this impacts what is learned (Heimlich et al., 2010). Some narratives allow students to take on roles and identities of scientists (e.g., Dunleavy, Dede, & Mitchell, 2009). This is one of the affordances of video games Gee cites, (2003) explaining that games can serve as a mediator between virtual and real identities, engaging students previously uninterested (Dunleavy et al., 2009). Narrative is commonly used in educational games (Dondlinger, 2007) and is effective when the learning goals are closely aligned to the narrative (Fisch, 2005; Malone, 1981; Waraich, 2004). Narrative has been invoked as a means to support students who struggle with the particular content (Waraich & Brna, 2008). Role-playing as scientists has been shown to help learners understand that the goals of science are not producing facts so much as developing and testing explanations (Solomon, Duveen, Scot, & McCarthy, 1992). Role play, especially when embedded in narrative that invests the "role with opportunities for action" (Barab et al., 2010, p. 240), has been shown to support learning (Hickey, Barab, Ingram-Goble, & Zuiker, 2008). Although much research supports the use of narrative, other research questions it necessity, suggesting that simulation alone may be better (Frasca, 2003; Habgood, Ainsworth, & Benford, 2005).

Methods

We co-designed two problem-based immersive units with teachers. This study reports initial enactments with these units, undertaken in courses for pre-service teachers. The first unit, *DomeStroids* focuses on arithmetic and geometric sequences with a narrative context of asteroids threatening to destroy all life on Earth; *DomeStroids* allows users to navigate through space with a skateboard and use a Wii-mote to test a secret weapon to blow up asteroids into a pre-specified number of pieces. Students spent three 50-minute class periods working in groups, with one class period in the dome (n=9). Roles (e.g., pilot, gunner) were assigned. The second unit, *ClimateDome,* focuses on the greenhouse effect and used a short version of a previously tested Web-based Inquiry Science Environment (WISE), (Slotta & Linn, 2009) unit on Global Climate Change (Svihla & Linn, 2012). The unit incorporated NetLogo models (Wilensky & Reisman, 2006) of the greenhouse effect. *ClimateDome* was used to reinforce understanding of the greenhouse effect, allowing the users to control the level of CO_2 with the Wii-mote, and then export data. The teacher did not provide a narrative context, but roles (e.g., CO_2 specialist, model engineer) were assigned connected to a setting (propose experiments to be conducted in the dome). Students produced graphs of changes in the overall heat of the system. Students spent two 75-minute class periods working in groups, with part of one class period in the dome (n=8).

Field notes and artifacts of student work were collected during the lessons, which were video recorded in accordance with field standards (Derry et al., 2010). Pre- and post-tests were used to document changes in understanding. We examine learning through interaction analysis (Jordan & Henderson, 1995) and as evidenced in assessments and artifacts. Elsewhere, we present analysis of pre/post changes in student learning, showing that in both units, students achieved learning gains (Svihla, Dahlgren, Kvam, Bowles, & Kniss, 2013).

Pre-dome session	Dome session	Post-dome session
DomeStroids (40 minutes) Teacher introduced the challenge in a narrative; students worked in groups on the cell division tasks; Students worked individually on the cell division tasks as homework	(50 minutes total) Teacher gave roles to the students; they practiced their roles; Teacher guided them through the activity for first part, (15 minutes); remainder of time spent with the "lights up" and working together on developing a formula, while still sitting under the dome; Students worked individually on the remaining asteroid tasks as homework	(10 minutes) Teacher gave brief lecture on sequences, with class discussion

ClimateDome (70 minutes) Students participated in a previously tested WISE unit on climate change (Svihla & Linn, 2012)	(40 minutes total) Teacher introduced *ClimateDome* and gave roles to the students; students planned experiments with the “lights up” (15 minutes); students carried out experiments they designed (25 minutes)	(40 min) Students finished the WISE unit on climate change and worked with datasets from *ClimateDome*

Table 1: Sequence of activities in *DomeStroids* and *ClimateDome*

Findings

We present findings related to how narrative and role-play supported *consequential engagement* (Gresalfi & Barab, 2011)but not necessarily with an understanding
of why one is performing such procedures.
 Conceptual engagement involves more
than plugging numbers into an equation, but additionally
involves understanding why an equation
works the way it does. In contrast, consequential
and critical engagement concern the coordination
of content, contexts, and learner decisionmaking. Consequential engagement involves
recognizing the usefulness and impact of disciplinary
content; being able to connect particular
solutions to particular outcomes.”302{Gresalfi, 2011 #5202}
</research-notes></record></Cite></EndNote> in *designerly* practices (e.g*., posing questions, designing investigations, modeling data*). We first highlight how this unfolded in *DomeStroids*, which included a narrative, then contrast this with *ClimateDome*, which did not have a narrative context.

Narrative context in *DomeStroids* invited participation

Initially, we see the students engaged with the narrative context, but not necessarily with the mathematical content and practices targeted by the unit. They focused on making the asteroids smaller, repeatedly firing the weapon, but not understanding how the weapon worked. The teacher encouraged them to shift their focus to the task at hand, saying “Okay, we gotta be systematic about this though. We can’t just go shooting -- shooting asteroids like space cowboys, right?” With definite guidance by the teacher, the students began to shift their approach to investigate the number of times an asteroid could be split, still grounding their discussion in the narrative context, but using it to investigate the mathematical content and practices.

1 Teacher: Wull:: cause one became three right so actually we only added (.)

2 Ss: Two

3 Teacher: Two more so how many did we have?

4 Ss: 22

5 Teacher: 22. Okay and then we did it again. We fired again. How many did we have after that?

6 Ignacio: So would there be a formula would be like uh the number of asteroids minus (.) minus one when it splits unto three

7 Teacher: You’re getting kind of the right ide-(.) I’m not sure what you’re saying

8 Ignacio: Minus one times two

9 Teacher: No not times two //

10 Ignacio: //plus two

11 Teacher: (.) You’re almost there you’re almost there.

12 Teacher: Can anybody help him out. What do you guys think the formula for this thing should be?

At first, we see the teacher guiding the students with very specific prompts (turns 1-5). At turn 6, Ignacio's question shifts the focus from answering the teachers' questions (in which we might claim conceptual engagement) to consequential engagement, in which they see utility in the content. This also marks an important moment in the class because Ignacio rarely participated in class. The teacher reflected on Ignacio's work, "He's written down the pattern, and he has uh::h generalized it to have a variable here, which is cool" (see Figure 2). Ignacio's model of the asteroids splitting with each hit shows his ability to represent data in disciplinary ways, even in the context of a fantasy narrative.

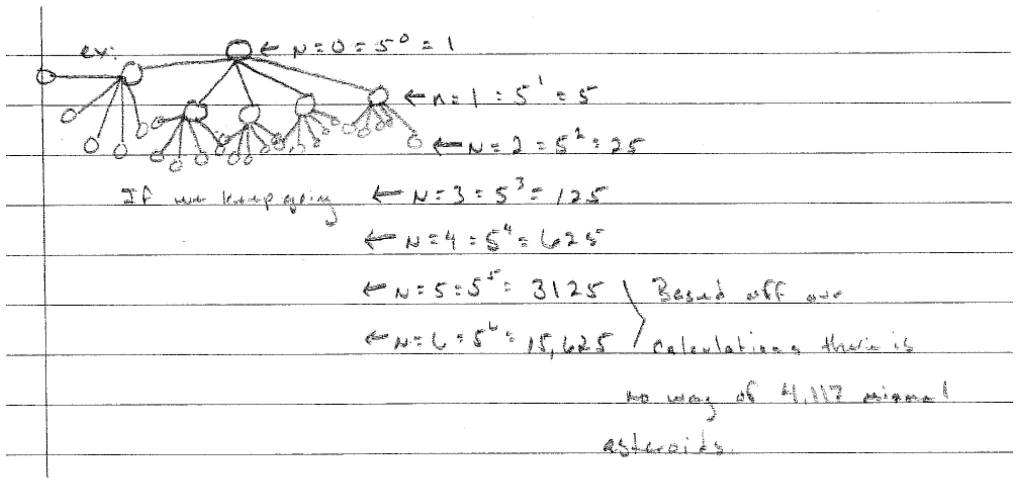

Figure 2: Ignacio's post-dome model of his algebraic expression, "number of asteroids =5(N)"

In the larger corpus of data, the roles are not very visible, though the narrative is, with students embedding their nascent understanding in the fantasy, and using it to engage consequentially.

Role-play and setting in *ClimateDome* supported question-posing

Although *ClimateDome* did not include narrative, the unit did provide a setting; students were asked to propose experiments that could be conducted in the dome. A student took on the role of Lead Scientist, deciding which experiments would allow them to efficiently explore the simulation of climate change. Students posed possible experiments based on their roles, focusing on CO_2 and infrared radiation (IR). He encouraged them to vary only one thing at a time, and after finding the baseline in the simulation, the Lead Scientist asked for proposals:

Student: We narrowed it down to a few questions. Our first questions was, "What happens to infrared radiation in the presence of CO_2 in the atmosphere. And depending on what kind of parts per million we are dealing with now, like current parts per million of CO_2 right now. And then say it's way higher than that, like by a factor of ten maybe. […] Umm, and then the level of infrared radiation would be the variable of interest and we would want to see if that had a direct correlation with the temperature or the heat. And the inverse of that, is what happens to the infrared radiation in the absence of CO_2 or very low parts per million.

In the larger data corpus, the roles –as scientists-- were consistently visible as students engaged, posing questions, negotiating the potential value in specific experiments, and interpreting results. After they returned to the classroom with data from the simulation, they modeled it, surfacing further questions such as why there was more solar radiation than heat energy and infrared radiation, why the overall heat of the system increased when there was a higher level of infrared radiation, and why variables changed together. Overall, the experience was generative and the students were consequentially engaged, but the patterns of participation – meaning the level of participation by particular students and the exchanges between particular students – largely reflected normal classroom participation (based on video and field notes of two other class periods). Students who contributed infrequently in class, contributed infrequently in *ClimateDome.*

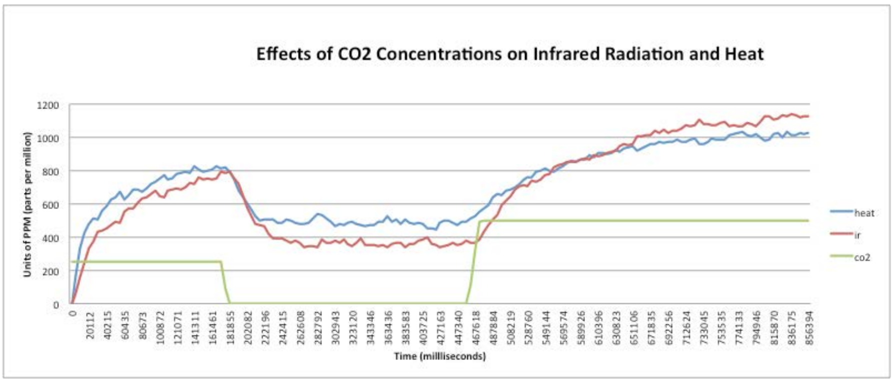

Figure 3: Example graph produced by a student using data exported from *ClimateDome*, showing the effects of CO_2

Conclusions and Implications

Although our findings are yet tentative and studies ongoing, we can draw initial conclusions about how immersive, interactive media can support learning when paired with role-play and narrative. In both units, student work and video data show evidence of learning and participation in *designerly* practices (e.g., posing questions, designing investigations, modeling data). This engagement was consequential, with students seeing how, when, and why to pose questions, pursue experiments, and model data. We see this as important particularly for future teachers because the majority of their prior content courses engaged them in *procedural* or *conceptual* ways.

By contrasting two different units with different foci, and with different learners, we are afforded the opportunity to consider why both units supported students to engage in *designerly* practices. First, we consider that the elementary pre-service teachers—typically fearful of math-- were successful in part because the narrative context invited them to participate in *DomeStroids*. In *ClimateDome,* the secondary science pre-service teachers were already comfortable with taking on the roles of scientists. Although this may seem to mean that narrative is not needed in such cases, we consider that there is still potential value in using it; the patterns of participation remained intact from classroom to dome, with a few students consistently participating less. This was not the case with *DomeStroids*, where we saw a struggling student emerge as a leader. While we cannot definitely attribute this reconfiguration of participation to the use of narrative, we do intend to pursue contrasts with future iterations to clarify this. The narrative may have invited participation from a broader range of students, including those who rarely participated.

Although these pilot studies show promise for teaching and learning with immersive, interactive technology, we cannot disambiguate the impact of the technology itself. Further studies are needed to understand how and why the technology might support learning.

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Designing Gender: Modding in Minecraft

Kelly Tran, Ben DeVane, University of Florida
kelly@digitalworlds.ufl.edu, ben@digitalworlds.ufl.edu

Abstract: Technical knowledge and skill with digital technologies are essential to today's global workplace. One way in which learners can acquire these skills is through participation in affinity spaces for video games. By using and creating content in these spaces, learners have motivation to practice skills such as programming and digital art creation. In these spaces they can also gain experience learning from and teaching others, also vital skills for an information economy. However, as women tend to not participate in the affinity spaces for as many games, it is possible that they are missing out on valuable learning opportunities. The popular game *Minecraft* may prove an exception, because the game has many female fans. What follows is an investigation of how whether or not women are creating content for the game, and whether or not their creations are welcomed in the fan community.

Introduction

For many popular video games, players create modifications ('mods') to use and share with other players. Creating modifications for a game relies on a wide variety of skills related to digital content creation. For example, players use graphics software to create new art to be used in game: anything from using image editing software such as Photoshop to recolor existing objects and characters to creating entirely new art. Players use 3D graphics software to create new objects, and practice programming by creating gameplay modifications, which change the behavior and rules of part or all of the game.

These skills take time and practice to learn. However, to many players of video games, the motivation of modifying a favorite game makes them worth learning. Fans who enjoy modding practice these fundamental technological and design skills and in the process become more technologically literate. If women and girls are not using video games in the same ways as men, they are missing out on the opportunity to acquire and practice these crucial skills. As such, we will be looking at a specific gaming community to see if females are participating in modding practices in that community. We have chosen the popular Swedish game Minecraft. Minecraft is a game that encourages users to create their own content in a virtual domain.

This paper investigates the modding practices of female Minecraft players in order to build understandings about: a) how women begin to develop design skills through game play; and b) how players discursively frame gender in game-based affinity spaces. In this case study we describe how a female modder developed technical skills partly through collaboration with the Minecraft modding community, even as she faced unexpected controversy about portrayals of gender in her creation.

Framework

Games are more than isolated and individualized experiences in a virtual world; they are frequently the locus of intense collaboration and social learning as players explore their shared interests. James Paul Gee calls these sites of joint activity "affinity spaces" (2007), a group of people that participate in a semiotic domain— "an area or set of activities where people think, act, and value in certain ways" (p. 19). This is an important idea in video game studies, because it looks not just at the games themselves but at how people play them and the social spaces around them. As Gee and Hayes (2010) explain, it is essential to not ignore these aspects of games but rather "to see gaming communities, modding, and other practices associated with games as all part of gaming today". (P.7) Modding is a design practice, and designing is a form of meaning making. Design practices represent a literary practice that learners need to be able to engage in order to understand systems and complex problems, increasingly important in order to meet the demands of today's workplace (Games 2008).

Game play is not just a leisure activity; its also a semiotic enterprise and cognitive endeavor with important implications for gender. Game play often entails both meaning-making relative to the games *procedural rhetoric* and the development of mastery in computational practice. In the first case, Bogost (2007) argues that "Video games are usually created with some expressive purpose in mind; they represent models of systems or spaces that players can inhabit" (p.122). Video games, whether overtly or not, have messages like any other medium. Players can negotiate the game's designed rhetoric by rewriting the game with mods.

Games and game communities are also arenas where players develop computational literacies and technical practices. Brunner's (2008) study on a content creation site for girls, KaHooTZ, concluded that "games serve as an entry point to the culture of computing and information technology" (p. 41). Scholars of gender, media and education point out that games inspire young women's interest in informational technology.

Androcentric social norms can present barriers to women's access to and participation in gaming. A major obstacle to engagement with games for girls and women is that they might feel that games are 'for boys' and so it is not something they should be doing. As Taylor (2008) explains, "Many women have been given signals (from the broader culture and from the industry itself) that computer games are not meant for them" (p. 62). Women are often led to doubt whether being a female player of video games is in fact an 'allowable' and socially legitimized activity to begin with.

Scholarship has shown that women generally have differential access to games, whether from a lack of physical access or from perceived social barriers. Taylor (2008) elaborates that "It is too often assumed that women who do not buy computer games or choose particular titles are making an informed decision—that is, a negative decision about a game or a play mechanic— rather than one in which they simply have not had the access to experiment and formulate tastes and preferences..." (p. 62). Part of this investigation asks whether women feel welcomed in the Minecraft community. We look at whether and how women are participating in the modding community of *Minecraft* and examine how the broader Minecraft community responds to women's engagement with modding practice.

Minecraft: An Overview

Minecraft is a game about exploration, creativity, and design. The defining feature of the game is that its world is comprised entirely of cubes, which are made out of different materials. They are arranged in a variety of ways and make up every part of the game's environment. These cubes can be removed and placed at will by the player, and thus the world of the game is completely reconfigurable.

The topic of gender in Minecraft is of particular interest because it is intended to be a genderless world. The player's avatar is a blocky looking character that is meant to be a genderless human, as Minecraft creator Notch explains: "The human model is intended to represent a Human Being. Not a male Human Being or a female Human Being, but simply a Human Being" ("Gender in Minecraft", 2012). However, many players would like to see the option of gender in the world, feeling that the default character definitely appears to be male. As such, they create mods to introduce gender into the game.

The Minecraft community consists of many different spaces such as websites, forums, and even physical meeting places such as the yearly MineCon convention. As Lammers (2012) notes, affinity spaces take place not in a singular space or site, but rather "fan spaces can consist of numerous interconnected web-sites, discussion boards, and listervs" (p. 25). However, in the case of Minecraft, the official forums run by the game's developers is the largest single space for discussion of the game. More importantly for this examination, the vast majority of players mods are posted onto these official forums. As such, all research will take place on this site.

Method

The research here will be presented as a case study of one particular mod and the nexus of online social interactions that surrounds its creation on official Minecraft forums. The data presented in this paper grows out of purposive sampling methods as a means of exploring new areas of investigation and generation new research questions (Wodak, 2001). Like other forms of qualitative inquiry in which external validity is establish socially, through the accumulation and assessment of the collective body of research, this paper does not purport to demonstrate the external validity of its sample through its methods. Rather, it adopts utilizes a purposive, convenience sample (Stake, 1995) as a means of iteratively developing constructs of inquiry relative to gender, modding and literacy practices.

Discourse Analysis and Purposive Sampling

We have proceeded iteratively in our purposive sampling and examination of data (see Gee, 2005). First we surveyed the larger data corpus of modding discussion on Minecraft forums to identify several key elements of discussion. Second, we began to focus in more detail on interactional discussions, selecting samples of data that highlighted the following questions: (1) How do players discuss and debate the use of mods to change the portrayal of gender in the game? (2) How do players ask for and provide help to the mod's creator and other users? (3) How do players talk address the real-life gender of players and users? Third, using Gee's (2005) Discourse analysis, we focused in depth on pieces of data that provided generative answers to these questions.

This paper investigates the way in which the social semiotic artifacts of Minecraft a) game modifications and b) game paratexts (discussion forums and wikis) are mobilized in design practice relative to discursive forms of gender. Put more simply, this paper looks at the way in which the social meanings of gender are negotiated, reproduced and/or contested as players use Minecraft as a site of design and creative practice. Discourse analysis (Gee, 2005) fits well with this mode of investigation, as it looks at the way both linguistic and non-linguistic elements are combined to build social meanings, enact identities, share beliefs and express affiliation.

GenderSelectionMod

The mod we are looking at here is the GenderSelectionMod (the name of this mod has been assigned a pseudonym by us to preserve anonymity). This mod, created by a female fan, allows players to select a female character. This new character has a feminine shape and a female voice.

The mod is a much-discussed; the forum thread on which the mod is posted currently has 1606 replies, which is quite a few more than the majority of mod posts receive save for the most persistently popular. As of January 2013, this thread has existed for over a year and a half. The high reply count is in large part due to two distinct types of posts. The first are posts that debate the merits of the mod, and how players view the role of gender in Minecraft. The second type of post are ones that relate to learning or teaching, mainly centered around users giving or receiving technical help.

In-game, the mod is fairly straightforward. Upon installation of this mod, the player is granted access to a new character shape, the female character. This female character looks much like the original character, having the same blocky look. She is slightly smaller, and exclaims in a female voice when she takes damage, and has a small rectangle on her chest for breasts. The blockiness and angularity of the character fits in with the look of the rest of the game.

The mod's creator explains that her visual design grew out of both aesthetic choices and technical limitations. She believes that this character is consistent with the world of the game, but also notes that her alterations were much easier than the work that would be required in order to slim down parts of the character for a more feminine shape.

Results

The creation of GenderSelectionMod was both a social and technical process, transforming Minecraft into a site of creative enterprise instead of content consumption, as games are often framed. During the process of the mod's creation, the Minecraft forums became a very active space for both design collaboration and arguments about the gendered meanings associated with Minecraft and modding.

Three major themes can be found in online talk surrounding GenderSelectionMod, which engendered a quite a bit of collaborative and contentious discussion in the Minecraft affinity space. First, GenderSelectionMod was the result of a collaborative process that the author undertook with various Minecraft forum users, answering their questions and responding to their comments. In this way it provides a real-life snapshot of the creator's development of modding expertise. Second, the practice and modding opened up a space where this player could rewrite the gendered meanings that were designed into the game by its creator. There were also a vocal group of non-modding female players who strongly supported the female mod creator, and these players used the mod themselves. Third, the mod engendered discussion of the "real-life" genders of players and forum users. The topic became an issue of content as male-presenting forum users argued the 'gendering' in the mod was improper. The men of the community could also be very supportive, even if they were not themselves using it. Any negativity or attempts to exclude the females in the thread were quickly called out by other players.

Developing Expertise Through Modding

The mod's creator interacted with users on the forum on which she posted her creation, answering their questions and responding to their comments. Most importantly, she described the development process as it happens. She initially introduced herself as a novice modder, one who did not have all of the technical skills needed to make exactly what she wanted.

The mod she created requires two different kinds of expertise. One is expertise with 3D modeling software, which is necessary to create a new mesh (3D shape) for the character. The second is programming expertise, needed both to add her character into as well as to add a graphical interface through which the user can set his or her gender.

As the mod's creator continued to work on the mod and add new features over time, she posted updates about her progress, explaining how she was able to add more features as her expertise increased. Other users provided feedback, suggested features, reported problems, and generally let her know what they thought of her creation. The vast majority of these posts were encouraging. Other users complimented her work and encouraged her to keep adding new features. When she stated that she didn't know how to implement some features that she wanted to, more experienced modders offered up solutions to the problems that she was experiencing.

One example of this back-and-forth problem solving occured when a user reported an error. The user that was reporting this error explained that the zombies (one of the monsters the player must fight in the game) were now female as well. This user provided a screenshot of the zombies, which now shared the player's female shape. The creator expressed her amusement and surprise and said that she would try to figure out how to fix it. At this, two other users offered solutions to her problems.

She soon after fixed the problem. It is worth noting that she was receiving enough assistance that several solutions were offered to the same problem. This is not the only time this happened throughout the thread. It is also worth noting that the users offered not just technical advice, but design help as well. During the course of the mod's creation, the mod creator implemented more advanced features as they were requested, such as the ability to use the mod in multiplayer games. Her updates became increasingly frequent. When one user reported that the gender mod is conflicting with another mod in use, the mod's creator explained that

If PlayerAPI/SmartMoving doesn't function properly when this mod gets installed second, I shall look at its code for that class and see if it would be possible to provide a simple patch, (and contact the dev. about this).

Here, her language is much more technical than it was early in the thread, and she does not apologize for the error like she does for almost all earlier ones. She offered a solution: she would try to provide a patch (an update which will fix the bug), and also stated that she would contact the developer of the mod.

When she stated that she would contact another developer to fix a problem that had been reported, she positioned herself as a more veteran player, one that engaged in technical and design speak with other modders. The confidence that she gained over time is readily apparent in her more technical language and the frequency with which she herself answered questions and problems that arise on the thread.

Rewriting Gender Portrayals

The idea of introducing gender into the game was hotly debated in the forum. As such, the reaction to the mod was mixed. On one hand, there were players who were very grateful for the option of a female character:

> I appreciate what you're endeavoring to undertake here. Gender is often poorly represented in games. On the other hand, some posters don't understand the need for a female character, especially since the default character is supposedly without gender.

On the other hand some players were against the mod because they did not want gender to be an option in Minecraft. These players felt that the world is supposed to be genderless and did not understand why a female character was needed.

> does it really bother you THAT much about the voice that you cannot even simply stand playing as a guy (which is only noticeable when you take damage I remind you) that you have to change it.... I find this mod unessisary [sic] but that is my opinion... I will support the voice change, sure... but beyond that this mod is going a bit far.

The central divisive issue here seems to be whether or not players accepted the premise that Minecraft is a game without gender. Many female players argued with this premise. The following post summarized the argument that Minecraft is already gendered and that the main character is male:

> Don't throw the "asexual avatar" bullcrap.
> -It grunts like a man.
> -it looks like a man.
> -it has the complexity and the body of a man.

This was a common sentiment among both male and female players based on discussions on this forum, although many of the most impassioned posters on the subject were female.

Real life gender

There was also much discussion on the real-life gender of players who used and supported this mod. There were many expressions of concern over the mod's only audience being 'perverted' men who want to play with a female character.

> Its sad cause it'll be 10% girls using this. the other 90% will be pervs [sic]

This played off the assumption that women do not play Minecraft or video games more generally. There were also a number of posts which joked about how the female should be good at cooking, weak, and other female stereotypes. However, the number of these posts was small compared to the number of posts which counter them:

> If you like it, sure, download it and enjoy it too! If you don't, then be quiet and look elsewhere for a mod. Don't post if you don't have anything constructive to add to the topic (snarky remarks or comments don't count as constructive).
>
> dont be sexist people!! really?
>
> I mean imagine how you would feel if notch had made the avatar a girl and not a boy. A girl with girl sounds. Im sure at some point someone would want a male skin with male sounds. Girls play this game too ya know

The posters who wrote to counter sexist or offending posts were both male and female. It is clear that this discussion of sexism and lack of female players was about not just the game, but gaming communities more generally.

Discussion

The exchanges between the mod's creator and experienced players who helped her is an example of apprenticeship in the affinity space. It shows the mod's creator was able to utilize other player's expertise, and was therefore able to create something with her initially limited expertise that she would not have been able to do as easily without help from other members. In his study of the site Kongregate, Duncan (2012) studied the way that players can learn design through an affinity space, believing that "particular community provides researchers with a unique opportunity to see how gamers can be scaffolded into designers through intersection with an affinity space that features the use of shared reference materials, instructional materials, design tools…" (p. 56). The mod's creator did not have all of the technical expertise to create the mod as she wanted it, but by using the knowledge at her disposal provided by other users in the forum, she was able to slowly make her mod the way she wanted it.

Negotiating meaning

The debate over whether or not gender should be modded into the game showcases the real meaning of modding: to rewrite a game and its core mean. Many players of Minecraft, especially women, do not accept what they see as a tacitly male rhetoric of this supposedly genderless world and seek to change it.

The addition of gender to the game is therefore a modification of the game's existing world. The amount of debate around this addition further illustrates that the meaning of the game itself is being changed, and argument about whether the mod should exist shows resistance to this change. Users who are genuinely upset at the idea of adding gender to the game believe in the given meaning of the world, that is is genderless, and hence do not understand why this needs to be addressed.

Conclusion

Female players not only gain technical and creative skills from playing video games and participating in affinity spaces, but they can use these skills to contest the gendered meanings designed into the game. In this case the mod creator advances from an unsure beginner to an advanced modder dealing with artistic and technical problems. While the forum thread she created was initially filled with talk about whether or not the mod should should exist, eventually discussion focused on new features and compatibilities with other mods, a result of the determination of the author and like-minded players.

Further studies such as Tran (2013) do indicate that the perceptions of female modders in this community may be more complex than they appear in this case. While this case study has limitations - the data here may not be indicative of broader trends in the frequency and reception women's modding practices - it does present compelling findings that are worthy of further investigation.This is a case of a female player without much technical background gaining knowledge and expertise motivated by her passion for Minecraft. She saw a message in the game that she did not like, and set about changing it. She felt that creating this content and sharing it was a valid option, and was met with much support and encouragement.

At the very least, the presence of female modders in Minecraft deserves further research and investigation. If women are to keep up with men in the area of technical expertise and digital know how, skills which are essential in today's information economy, it is vital that they too are able to gain these skills through participation in gaming affinity spaces.

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The Effects of Customization on Game Experiences of a Massively Multiplayer Online Game's Players

Selen Turkay, Harvard Initiative for Learning and Teaching, Harvard University
Charles Kinzer, Teachers College, Columbia University

Abstract: This study investigated the role of customization as function of user control in a Massively Multiplayer Online game (MMO), *Lord of the Rings Online*. It extends and adds to the studies examining the effects of choice as a vehicle to understanding users' dynamic relationships with new media. Sixty-six participants data were collected over ten hours of gameplay in four sessions to measure the effects of customization on players' reported experiences. Participants' game play experience was assessed with Likert Scale questionnaires and semi structured interviews. Results indicate that players who were able to customize various aspect of the game were more engaged in gameplay than those who did not get to customize. Additionally, the customizers' engagement increased as amount of gameplay time increased . The theoretical and practical implications of these findings are discussed within the context of game design and research.

Introduction

The educational merits of games are being increasingly recognized by the public and the government. However, as teachers and the general public are introduced to the unique value of videogames, game developers and game researchers must provide answers to questions related to the effects and values of various games' characteristics so that teachers and parents can select games that will engage children with the content they want children to learn.

An initial step is to identify characteristics of videogames that make them engaging. With the idea of considering videogames as "designed experiences" (Squire, 2006, p. 24) where every design decision shapes learning and engagement through the various "structures and contexts in which play takes place" (Salen & Zimmerman, 2004, p. 67), studying player experiences helps researchers understand which design aspects influence the processes involved in creating different game experiences.

Poels, de Kort and IJsselsteijn (2012) argue that game experience has to be studied as a multidimensional concept. Positive videogame experience is related to intrinsic motivation (Przybylski, Rigby, & Ryan, 2010), immersion (Jennett et al., 2008), flow (Csikszentmihalyi, 1990), as well as presence and enjoyment (Klimmt, Hartmann, & Frey, 2007). One of the common requirements among these concepts, all related to positive game experiences, is their emphasis on user control.

This reported study herein investigates the impact of user control in the form of customization on players' game experiences by using subjective responses from players of a Massively Multiplayer Online Role Playing Game (MMORPG), *Lord of the Rings Online (LotRO)* (Warner Bros. Entertaintment Inc., 2013). We wanted know whether customization can have empirically assessable impacts on player experience. Therefore, we asked following research question: How does being able to customize in an MMO affect player experiences such as challenge, positive affect and flow over ten hours of gameplay?

Background

Several studies of videogames have determined a number of attributes that foster engagement, such as feedback, intrinsic motivation, fun, and players' sense of social presence, challenge, social contexts, and achievement (Hoffman & Nadelson, 2010). A recent mixed methods study (Hoffman & Nadelson, 2010) suggests, "when the degree of control is accompanied by positive results, participants experience enhanced engagement due to increased self- efficacy" (p.262). Poels *et al*. (2012) found nine specific game experience dimensions in their focus-group study: enjoyment, flow, sensory immersion, imaginative immersion, suspense, competence, control and social experiences. Jennett *et al*. (2008) identified five factors of immersion: cognitive involvement, emotional involvement, real world disassociation, challenge and control. Sweetser & Wyeth's (2005) GameFlow model provides a set of general criteria for designing and evaluating games by mapping flow to GameFlow elements. One of the essential elements listed in the model is players' sense of control. Control in games mostly related to players' felt effectance of their actions, and is therefore connected to emotional evaluation of the players' ability to exercise control.

Leotti, Iyengar, and Ochsner (2010) have argued that opportunities to exercise control may be necessary to foster self-efficacy beliefs. They further assert that “each choice–no matter how small–reinforces the perception of control and self-efficacy, and removing choice likely undermines this adaptive belief” (p. 4). Providing choices, in fact, may be central to game play, reinforcing Salen and Zimmerman’s (2004) argument that games can be seen as “systems whose meaning emerges from the experience of players as they make choices in a game” (p. 316). Yee (2007) found that choices concerning appearance, accessories, and color scheme in games were important subcomponents of massively multiplayer online game players’ motivation while Turkay and Adinolf’s (2010) study showed that sense of control and customization are correlated and valued as aspects of player engagement. Psychologically, customization can imbue a strong sense of agency (Sundar, 2008) by letting players specify their preferences and modify the game to make it more relevant to them.

The above-noted research centers around customization and choices provided to players within an MMO. However, customization is not a new phenomenon in human activities. People customize their environments every day (e.g., rooms, desks), belongings (e.g., clothes, jewelry), and technologies (e.g., mobile phones, software). As a consequence, customization has been studied widely in several fields, but there are different interpretations of what customization means, what motivates people to customize and what the effects of customization on user behaviors are, and there is very little research on the process of customization and its effects over time. Theories that might be relevant to customization are those that attempt to explain the motivational appeal of choices.

Emerging technologies such as mobile phones, web portals, and games introduce additional, broad possibilities of customization of appearance and function. Decades of psychological research suggests that giving individuals choices leads not only to better performance and more intrinsic motivation when performing tasks but also to more overall satisfaction (Lewin, 1952). Many theories in social psychology relate self-efficacy and a sense of control to intrinsic motivation, persistent efforts to succeed, enjoyment (Csikzentmihalyi, 1990). These in turn lead to better performance in the task at hand (Cordova & Lepper, 1996). The motivational aspect of choice has been part of many motivational frameworks, such as Eccles and Wigfield’s (1995) expectancy-value model of achievement motivation, Bandura’s (1997) social cognitive theory, and Deci and Ryan’s (1985) Self Determination Theory (SDT).

This study will discuss the findings through the lens of a sub-theory of SDT, cognitive evaluation theory (CET). CET states that activities that foster intrinsic motivation are those which satisfy three basic needs: The need for competence (sense of efficacy), autonomy (volition and personal agency) and relatedness (social connectedness; Ryan & Deci, 2000).

Methods

Participants and Design

Participants were recruited through fliers on public billboards at a medium-sized East Coast University and were remunerated $50 ($5 per hour) for their time. Participants were selected based on their experience in MMOs, based on a survey provided to people who responded to the flier. Those who were not expert MMO players, who were not current MMO players and who had not played *LotRO* were invited to participate in the study. 160 people responded to the flier and 75 were invited to participate. Of those 75, 66 participants (32 males, 34 female) completed the study. Participants were adults between 18 and 35 years old with a mean age of 25.63. This is very close to the average age of MMO players (M=26.6) as reported in a previous, large scale study (Yee, 2007).

This study used a between-subjects design and participants were randomly assigned to one of two groups, Customization (CG) (n=33; f=17, m=16) and No Customization (NCG) (n=33; f=17, m=16). In the CG, participants were given various choices in the game, such as the opportunity to choose their game characters’ specialties, skills, gender, and appearance as well as in-game rewards after they completed quests (see Figure 1 for examples). In the NCG, the participants were assigned to well-constructed pre-designed avatars with efficient character skills and quest rewards were chosen for them. In the NCG, avatar’s gender and participant’s gender were matched.

Stimuli. The game that was used in this study was *Lord of the Rings Online* (*LotRO*), a fantasy MMO based on the books by J.R.R. Tolkien.

Three different game accounts were generated for the study. *LotRO* has 19 different servers. Players can play in one of these *LotRO* worlds, and some servers are more populated than others. Using multiple accounts made it possible for participants to play in populated servers to maximize the possibility of social interaction, which may affect player experience (Yee, 2007).

A gaming-optimized PC was used for the study, and participants wore a headset during the gameplay.

Duration of the study: MMOs are long term games and a reliable study of player behavior in these games should take place over more than one experimental session. According to Yee (2007) who collected data from 3,000 users of online games, the usage per week is, on average, 22 hours. The average time of play per character in one a week is 10.2 hours (Ducheneaut, Yee, Nickell, & Moore, 2006). A more recent study with *Everquest* players' gameplay data revealed that a regular player plays about 100-150 minutes at a game session (Mahmassani, Chen, Huang, Williams & Contractor, 2010). Based on the above studies, to be consistent with normal periods of gameplay this study's procedure involved about 10 hours of game play, which was divided into 4 sessions (2 to 2.5 hours per session) over two weeks.

Game Experience Questionnaire: To assess players' gaming experience, qualitative and quantitative data were collected. A Forty-two item, 5-point Likert scale *Game Experience Questionnaire* (GEQ) was conducted after each of the four game sessions to assess players' gaming experience (IJsselsteijn et al., 2008). The GEQ consists of seven subscales, each with six items: sensory and imaginative immersion (e.g., "I felt that I could explore things"), flow (e.g., "I lost track of time"), negative affect (e.g., "I felt bored"), tension (e.g., "I felt frustrated"), positive affect (e.g., "I felt happy"), challenge (e.g., "I thought the game was hard") and competence (e.g., "I felt skillful").

Semi-structured Interview: After the first and last game session, a 10-question semi-structured interview was conducted with all participants. With a subset of participants, interviews were conducted after second and third sessions as well. Some of the questions were: Tell me about your experience, what were the things that you thought were fun and frustrating, how did your experience change from the first session until now (asked only after the last session).

Data Analysis: A repeated measures multivariate analysis of variance (RM MANOVA) was employed to reveal differences on outcome variables over time (sessions) and to examine between CG versus NCG in terms of the subsections of game experience (e.g., challenge, competence, flow). These seven dependent variables were included simultaneously as dependent variables in this MANOVA to provide further protection against inflation of type I error when analyzing related dependent variables for which comparable independent variable effects are predicted (Stevens, 2002). Assumptions are met for the test. Statistical analysis software SPSS 20 was used to facilitate statistical data analysis and Nvivo 9 was used to facilitate inductive analysis of interview data (the results for one question is reported herein).

Procedure

Participants were provided with an informed consent document upon entering the laboratory for the experiment. After each participant read and signed the informed consent document, they moved to the gaming computer and the play procedure was explained. The gaming computer was connected to another computer to allow the researcher to control such things as starting and pausing screen captures, facilitating the procedure for NCG, and to capture real-time observations of participants' gameplay.

In the first session, the CG created their game characters and customized their appearance. NCG participants were assigned well-established, pre-generated characters that matched each participant's gender. Participants continued to play with that character throughout the study. For both groups, the first session ended upon completion of the *LotRO* tutorial (which takes about 2 to 2, 5 hours). At the end of each game session, participants completed the GEQ on the computer. After the first and the last session, a semi-structured interview was conducted to gain further insight about their experiences. CG participants were introduced to various ways they could customize the game (if they had not already found out in the tutorial) whereas NCG participants' choices were controlled. For example, the NCG did not choose their mission rewards, the researcher chose for them, binding the keyboard shortcuts for that purpose. NCG participants were told that the computer would make the reward choices for them until they learn the game. During the study, the researcher sat in a cubicle which had the mirrored monitor and keyboard to the participants' computer. Participants had no line of sight to the researcher's area. This allowed smooth control of NCG's choices. NCG's characters' appearance were set with the cosmetic outfit option in *LotRO* so that participants would see the same outfit no matter how their characters were equipped throughout the sessions. These differences controlled the CG's and NCG's autonomy and control by controlling their customization options.

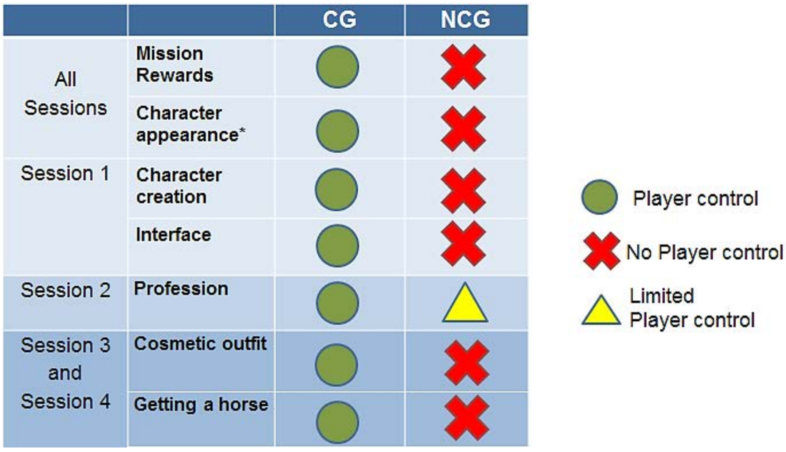


***Figure 1*. Examples of user customization in different sessions**

Results

Preliminary Analysis

Participants' demographic information was analyzed to examine consistency between groups. No statistically significant difference was found between groups in their mean age (CG = 25.89, NCG=25.53) and their experience with MMOs (t = 1.32, *n.s.*). A *LotR* familiarity score was generated based on participants' reports of how familiar they were with Lord of the Rings in various media forms, with no statistically significant difference being found (t = 0.944, *n.s.*). There was no statistically significant difference in favorite game genre or how they play games (e.g., playing games alone, with other people in the same room, with people online).

Change over four sesyou sions: Quantitative

Statistically significant multivariate effects were found for the main effects of group (F (7, 58)=4.597, p < 0.001, partial η^2 = *0.357* and time (sessions) (F(21, 44) = 2.434, p < 0.05, partial η^2 = *0.537*. The interaction between groups and time was not statistically significant. That is, the upward trend over time for all subjects is statistically the same for the customization group and non-customization group. The reason might be that two groups differed significantly at the end of the first session and there was a ceiling effect. Table 10.3 presents the means and standard deviations of the variables. Prior to conducting a series of follow-up ANOVAs, the homogeneity of variance assumption was tested for all nine intelligence subscales. Based on a series of Levene's F tests, the homogeneity of variance assumption was satisfied.

In order to test sphericity we applied Mauchly's Test which tests for the equivalence of the hypothesized and the observed variance/covariance patterns. The test was significant for all dependent variables except Negative Affect (W=.85, χ^2 (5)=9.89, *n.s.)* suggesting that the observed matrix has approximately equal variances and covariances. So, we used Greenhouse-Geisser test.

Follow-up RM ANOVAs revealed that the statistically significant change over four sessions was statistically significant only for sensory and imaginative immersion, (F (2.40, 153.34) = 6.66, p = 0.001, partial η^2 = .09), for flow (F (2.40, 153.34) = 5.04, p = 0.005, partial η^2 = .07), for competence (F (2.52, 161.43) = 8.18, p < 0.001, partial η^2 = .11). It was not statistically significant for Positive Affect (F (2.63, 168.29) = 2.68, *n.s.*) for challenge (F (2.67, 170.55) = *2.70, n.s.*), Tension (*F (1, 64) = 1.86, n.s.*) and Negative Affect *(F* (2.70, 172.54) = *2.63, n.s.*) Time was a statistically significant predictor of Immersion, Flow and Competence. Time and groups did not interact to predict the changes in dependent variables.

Tests of Between-Subjects effects showed that group (CG and NCG) was indicative of changes in Immersion (F(1,64) = 16.39, p < 0.001), in Flow, (F(1,64) = 18.27, p < 0.001), in Competence, (F(1,64) = 8.82, p < 0.005), in Challenge, (F(1,64) = 7.21, p < 0.01), in Positive Affect (F(1,64) = 25.33, p < 0.001), and in Negative Affect *(F*(1,64) = 7.63, p < 0.01). (Statistically significant main effect of group is found) Table 1 shows the results of independent samples t- tests for each dependent variable for each session.

Test of Within-Subjects of Polynomial Contrasts shows that there is a statistically significant linear relationship between sessions and immersion (F(1,64)=12.50, p < 0.001), sessions and flow (F(1,64) = 7.93, p < 0.01), sessions and competence (F(1,64) =14.91, p < 0.001), sessions and challenge (F(1,64) = 5.82, p < 0.05), and sessions and positive affect (F(1,64)=4.44, p < 0.05). There is a statistically significantly cubic relationship between sessions and negative affect (F(1,64) = 4.80, p < 0.05). There is a quadratic relationship between challenge and the interaction between sessions and groups (F(1,64) = 6.32, p < 0.05). These trends can be seen in the Figure 1 and Figure 2.

	Levene's		Independent Samples t-test			CG		NCG	
	F	*p*	*t*	*p*	η^2	*M*	*SD*	*M*	*SD*
Sensory Immersion 1	1.149	.288	2.85	.006	.12	3.37	.75	2.81	.82
Sensory Immersion 2	.856	.358	-4.51	.000	.50	3.51	.66	2.71	.73
Sensory Immersion 3	.221	.640	-3.58	.001	.50	3.60	.71	2.93	.81
Sensory Immersion 4	3.924	.052	-3.24	.002	.38	3.70	.72	3.04	.94
Flow 1	.841	.362	2.39	.020	.08	3.29	.77	2.80	.89
Flow 2	2.880	.095	-3.62	.001	.42	3.31	.77	2.73	.97
Flow 3	9.127	.004	-4.25	.000	.47	3.65	.67	2.74	1.03
Flow 4	5.158	.027	-3.79	.000	.43	3.76	.75	2.92	1.03
Competence 1	1.333	.253	-1.38	.171	.05	3.06	.82	2.71	.70
Competence 2	.347	.558	-2.03	.047	.29	3.12	.77	2.68	.73
Competence 3	.603	.440	-2.30	.025	.28	3.30	.76	2.88	.71
Competence 4	.005	.945	-2.62	.011	.31	3.58	.79	3.06	.82
Tension 1	1.268	.264	.07	.947	.00	2.51	.60	2.46	.67
Tension 2	1.063	.306	.39	.695	.07	2.57	.80	2.67	.68
Tension 3	.196	.660	1.29	.200	.16	2.35	.73	2.57	.67
Tension 4	.608	.438	3.03	.004	.35	2.14	.69	2.66	.70
Challenge 1	.829	.366	-1.99	.051	.23	2.93	.64	2.69	.67
Challenge 2	.037	.848	-2.83	.006	.33	3.17	.62	2.74	.65
Challenge 3	.283	.597	-2.99	.004	.35	3.25	.63	2.74	.65
Challenge 4	.045	.833	-1.21	.229	.15	3.16	.69	2.96	.64
Positive Affect 1	.719	.400	-2.28	.029	.28	3.49	.74	3.16	.65
Positive Affect 2	.317	.575	-3.69	.000	.43	3.66	.74	2.93	.80
Positive Affect 3	1.083	.302	-4.44	.000	.49	3.87	.65	3.08	.79
Positive Affect 4	.005	.944	-3.90	.000	.44	3.89	.70	3.21	.71
Negative Affect 1	.329	.568	.80	.427	.12	2.41	.74	2.53	.72
Negative Affect 2	.718	.400	2.60	.011	.33	2.33	.65	2.82	.75
Negative Affect 3	.616	.435	2.59	.012	.31	2.13	.62	2.59	.81
Negative Affect 4	.225	.637	2.22	.030	.27	2.16	.72	2.56	.73

Table 1. Statistics for subdivisions of GEQ for four game sessions.

Change over four sessions: Qualitative

Several patterns emerged related to change in participants' gameplay experience over ten hours. The most prominent patterns related to increased enjoyment (CG=16, NCG=5), increased confidence (CG=20, NCG=13), and increased autonomy (CG=12, NCG=2). Although these are somewhat connected to each other, many participants talked about them independently. For example, when participants reported their increased enjoyment, they talked about various reasons for this change. Below are some of these reasons, together with a representative quote and the number of participants who mentioned that reason in their answer per condition.

1) Increased confidence and competence (CG=13, NCG=4). *"..I think it became a lot more fun because you learn*

how to do things and it gets less confusing and you get more comfortable with all the things going on at once. So it was more fun."-ID27

2) Autonomy satisfaction (CG=5). "*It was great. I think it has become more interesting from first session to the fourth session. I can do more choice. Especially today I got a mount and that is pretty cool.*"-ID33

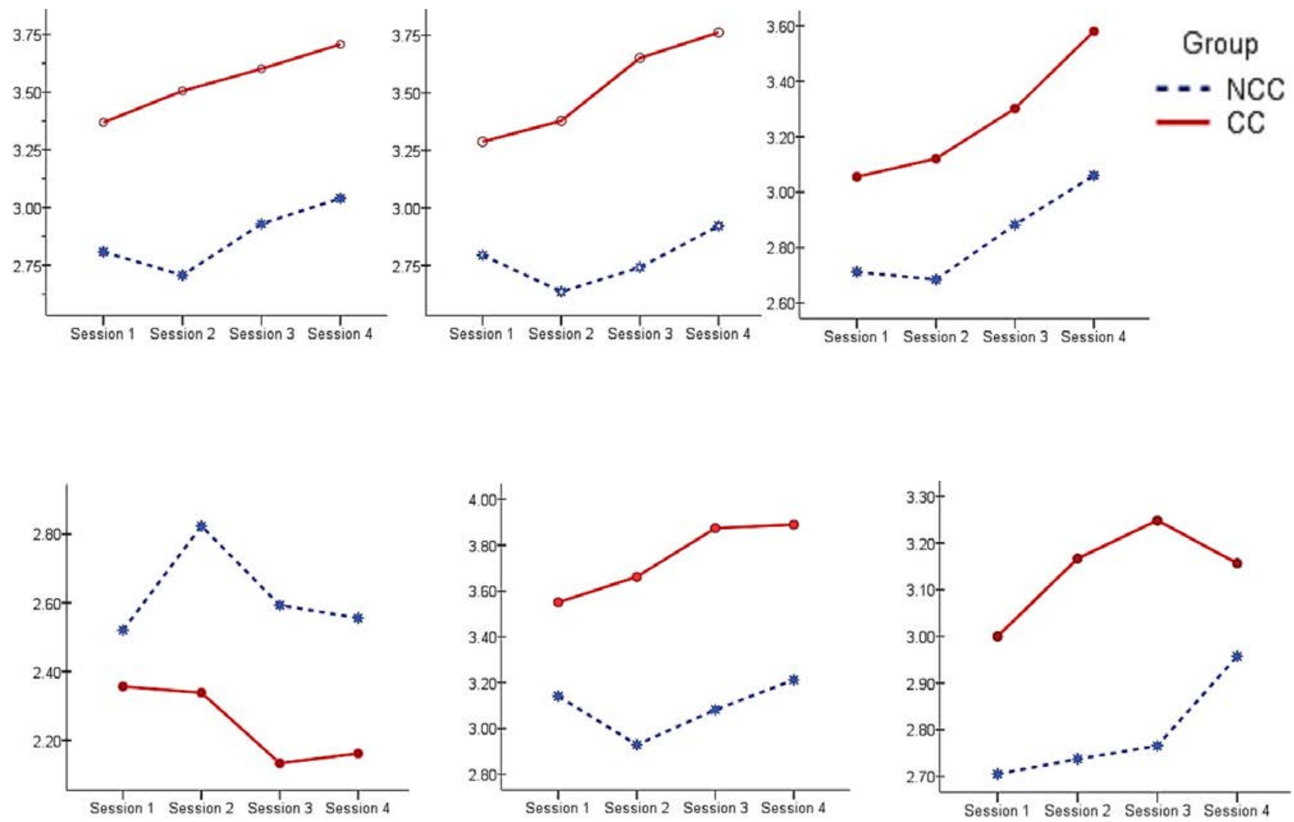
3) Awareness of social aspect (CG=4). "*I tried a lot of new things like talking to somebody which is very interesting or using other people as allies I think overall as I did more hours I started to enjoy the game more than try more new things*."-ID47;

4) Increased motivation for exploration (CG=4). "… *I was more drawn into it as I played more. Also definitely I started looking at different maps and seeing that the world included all different places in the middle Earth was very exciting*." –ID19

5) Increased sense of flow (CG=2): *"The time passed so fast I didn't even realize. Because it was three hours and I was like "Wow" I really got into it but compared to the first day I remember looking at the clock and waiting for time to pass… but at the end I got really drawn into it…"* –ID57

6) Increased narrative involvement (CG=2): *"After started reading the quests I started getting more interested in what was going on the world more so than I realized in the beginning for me that was really different. "* –ID31

Players reported that once they got familiar with the physical controls and mechanics of the game, it became more enjoyable. Also, increased number of choices is related to players feeling challenged. Although it was enjoyable for the following participant: "*I think it is more challenging because I have more tasks and I think I have more freedom to choose what I want to do, to take the task or not."* –ID59, this was not the case for others. Four participants, for example, reported that increased complexity and challenge due to exponentially increasing choices overwhelmed them.



Discussion and Conclusion

The purpose of this study was to contribute empirical data to inform educational game design decisions relating to user control. Results indicate that being able to customize affects players' experiences. Starting from the first game session, CG was more engaged in game play than NCG. Participants' reported sensory and imaginative immersion, flow, and competence changed statistically significantly over four sessions. Although this change did not show different behavior for CG than NCG, customization heavily influenced players' sensory and imaginative immersion, flow, competence, negative affect, positive affect and challenge over four sessions (see Table 1).

In MMOs, players are introduced to more choices in form of customization as they level up. In CG, being able to customize various aspects of the game increased players' autonomy satisfaction, which increased their game enjoyment. This supports previous studies that indicate perceived autonomy results in higher levels of intrinsic motivation and enjoyment of games (Przybylski, Rigby and Ryan, 2010). From the qualitative data, it was clear that players' autonomy (having more choices and being able to explore) was also related to their sense of competence which may be facilitated by the leveling mechanics and progression in the game. As players progress, they are provided with more choices, and gameplay also gets more challenging, satisfying players' sense of competence. Players also gained confidence as they mastered game controls over time. This can explain the linear relationship between sessions and players' sense of competence. MMO interfaces are rather complex, which makes the learning curve steep. Once players were able to pass that barrier, they started to enjoy the gameplay. Being able to customize interface features facilitated that passage.

This study suggests that long-term game play elicits a significant increase in players' positive game experiences when they can customize game features, especially avatar based ones. Thus, customization is an important design feature for player engagement in MMOs and educators are advised to build-in strategic customization possibilities to maximize the potential for learning.

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“I am sorry my friend, I love you, but I don’t trust you”: Social dynamics in a multiplayer collectible card game

Selen Turkay, Sonam Adinolf, Devayani Tirthali
Teachers College Columbia University

Abstract: This paper reports results pertaining to different social interactions among players of a popular multiplayer collectible card game, Vampire the Eternal Struggle (Vtes) over the course of a competitive game in a national championship. Video of an 80-minute long single gameplay session with five players was analyzed by using inductive coding. Findings showed eight main categories of social interactions: social banter, strategies, out-of-game comments, reflection on gameplay, negotiations, clarifications, complaining, and praises. Relationships between these social interactions and time were also identified revealing dynamic nature of social interactions due to multiplayer aspect of the game. The practical and theoretical implications of the findings are discussed within the context of game design and research.

Introduction

Development of information communication technologies enabled users to interact via many tools including online multiplayer games. While the interaction among the players of these games, and design principles for these interactions particularly Massively Multiplayer Online Games (MMOs) have been of interest to many scholars (e.g., Ducheneaut & Moore, 2004; Zagal, Nussbaum, & Rosas, 2000), with some exception (Xu, Barba, Radu, Gandy, & MacIntyre, 2011) little attention was given to examine social interactions of non-digital games especially collectible card games (CCGs).

Collectible Card Games (CCGs) combine the element of collection, with that of creation. A player may own many cards, but he must choose which ones he wishes to assemble into a deck. For a more in depth discussion see Adinolf and Turkay (2011). Considering the popularity of CCGs among school aged children and the surge of online CCGs in the market, the lack of interest from educational game community towards the study of CCGs is surprising. When designing an online version of a non-digital game, it is important to know what the affordances of tactile objects and co-located play on player experiences is. For example, Xu et al. (2011) investigated the social interactions based on how interaction is initiated by analyzing the recorded videos of four different card and board games. In their study, nine participants were invited to play these games weekly basis. Authors do not provide any information about players’ experiences. This might be important since experience with the game as well as players’ familiarity with each other may change the social interactions among them.

Social interaction between players is the key to the success of multiplayer games of any kind (Costikyan, 1998). It can be categorized into internal and external social play (Salen & Zimmerman, 2004). Internal social play is about social interactions that stem from the gameplay whereas external social play happens when people carry their existing real world roles into their gameplay.

The previous study with V:tes community (Adinolf, Turkay, & Tirthali, 2012) revealed players’ belief about game mechanics contributing greatly to the strength of the game community. This begs the question of what kind of interactions may take place during a gameplay session. Using qualitative video analysis as the main research method, this study aims to investigate different types of social interactions triggered by game mechanics and their density over the course of a gameplay session. The specific research questions are:

RQ1) What kind of game design elements of V:TES affect different kinds of social interaction?

RQ2) Does frequency of social interactions change over time?

The Game

Vampire: The Eternal Struggle, or V:TES as it is commonly called is a multiplayer collectible card game. In tournaments, the game is usually played with 5 players in each game. The format of the game is that each player would like to “oust” the player to their left, their “prey”. That means the player to their right is their “predator”, who wants to oust them. If a player’s prey is ousted, even if they didn’t do it themselves, that player receives one “victory point”. The winner of the game is the player with the most victory points when the game ends, either due to only one player remaining, or time running out (2 hours is the standard time limit). The last person left standing receives their own victory point. Thus, it is possible, though very infrequent, for a player who has been ousted earlier to be the winner when the game ends.

A V:TES player has two decks, one large and one small. The small deck, called the “crypt”, contains cards with vampires on them. These will be the “minions” that the player “influences” to do their bidding. The vampires must be influenced from the player’s “pool” of influence, which is also their life. So, players must balance their desire for stronger vampires with the extra cost that must be paid, which makes the player more vulnerable. The second, larger deck is called the “library”, and contains cards both for the player’s and their minions’ use.

Method

Participants and Setting

Players in the North American Championship (NAC) of VTES were informed about the study. We determined that we wanted to analyze the final table dynamic in the tournament. We chose a championship game because of the facility with the mechanics implicit in the players. This ensured (as best as can be with human beings) that the decisions we saw were deliberate, not the result of imperfect understanding of the game. This is especially important for a complex game like VTES.

The final table consisted of five players (whose names are replaced with pseudonyms for the paper). Seated around the table in clockwise order were: Marleybone, Jeremiah, Bartholomew, Randolph, and Sibella. Marleybone was playing a Malkavian stealth and bleed deck, with some defense in the form of bleed reduction and redirection. Jeremiah was playing a deck with larger vampires with political actions and bleed with stealth, as well as a lot of pool gain to help survive. Bartholomew was playing a very simple Malkavian stealth and bleed deck with just a little bit of intercept and redirection. Randolph was playing yet another stealth and bleed deck with lots of small or mid sized vampires and their allies. Sibella rounded out the stealth and bleed set with a deck very similar to Marleybone’s, but (it turned out) with even more aggression.

If all of those deck descriptions sounded similar, that is because they are. All of them have a moderate to high level of “bleed” increasers, with the idea that bleed is the most straightforward way to reduce one’s prey to 0 pool. All of them also had a moderate to high amount of stealth, which helps to have your actions succeed. So they were all (with Jeremiah being the possible exception) playing decks of the most simple sort, designed to attack their prey with little to no thought for the other 3 people at the table. Is this usual? As someone who has attended tournaments of various sizes and formats, I can say no. Different venues have different “metagames”, or styles of deck which are prevalent. None is more aggressive than day 1 of the North American Championship (NAC). While being a tournament in its own right, with a final and prizes, day 1 of the NAC also determines which players get to continue on to play in day 2, with roughly the top 40% doing so. This extra metric serves to encourage people to play decks that can grab a Victory Point here and there, barring extreme misfortune. Thus, at least in theory, you will make the cutoff just based on playing the odds.

Data Analysis

In total, 80 minutes of gameplay video were captured. First author transcribed the audio of the game video as well as recorded the social and physical behaviors of players. Nvivo 9 was used to facilitate qualitative data analysis. The transcriptions and recordings were grouped into categories of social events. In total 412 social events were transcribed.

Findings

In total eight categories of social interactions emerged from data: 1) Negotiation and discussion; 2) Clarification and instruction; 3) Social banter; 4) Reflection on gameplay; 5) Strategies; 6) Out-of-game comments; 7) Encouragement and praise; 8) Complaining. Below we will discuss each category briefly. See Figure 1 for the distribution of these over the 80 minutes of gameplay. It is apparent from the figure that most diversity of social interactions took place between 40 minutes to 60 minutes in the game.

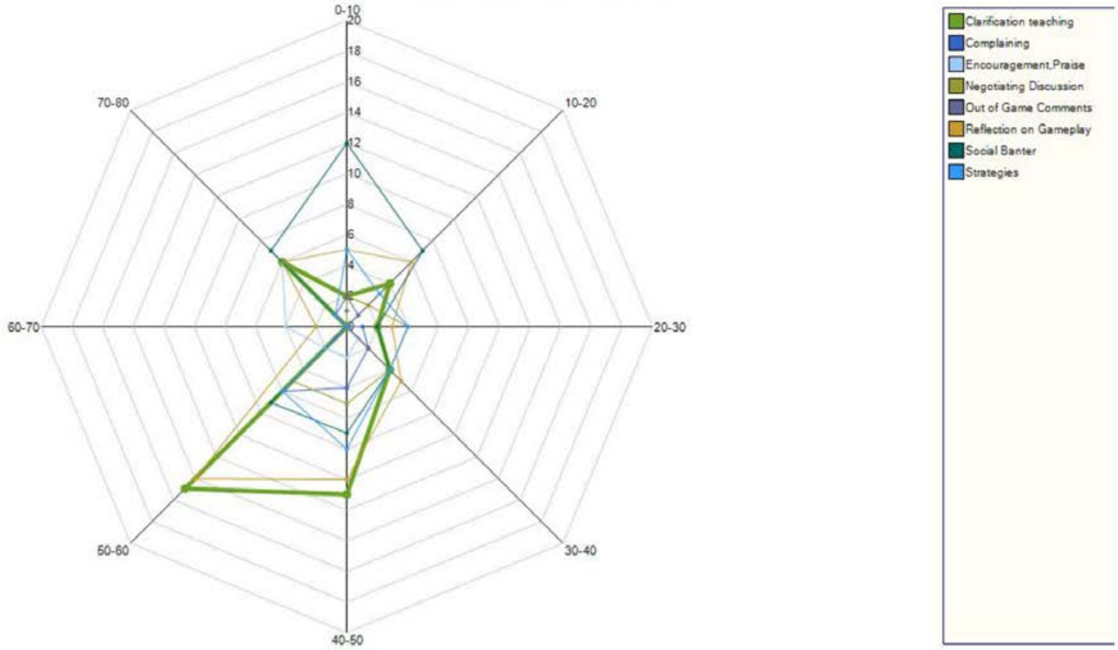

Figure 1: Radar display of the different types of social interaction over for 10 minute time sections over 80 minutes.

Negotiation and discussions

Negotiation is one of the main strategies people use in V:tes. Due to the nature of the tournament, there were less deal making and more aggressive deck types in the final game table. Despite that, we identified 22 different occasions of deal making and discussion events. In the following example, both B and J are working together against B's prey and negotiating their strategy:

> B: *So* (addressing J) *you're happy with me bleeding irresponsibly?*
> [He points out that bleeds might get bounced around to J.]
> J: *Yes, bleeds might get bounced. I can probably weaken him with votes, but I can't do all the work for you.*

The chart below shows the distribution of individual negotiations and discussions players had over the course of the game. As can be seen, negotiation activity during the middle four time segments is more dense, whereas during the last two segments there was no negotiation. This is because the game involved only 2 people after the 60 minutes.

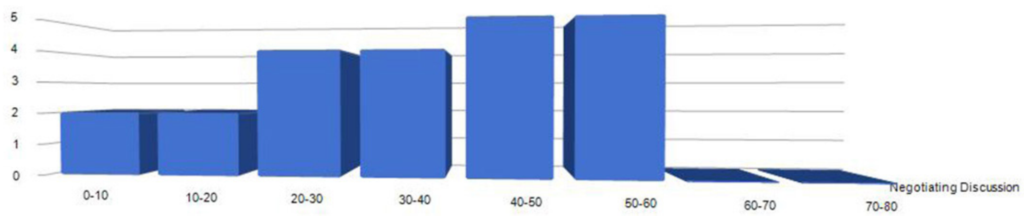

Figure 2: Number of negotiations took place over the course of the 80 minute game.

Clarification and instruction

One undeniable characteristic of V:tes is its complexity. The multiplayer aspect of the game adds another layer of complexity on top of the game's rules. Tournaments have to have a judge to resolve any confusion and enforce the rules of the game if necessary. Interactions with the judge consisted of merely rule clarifications during this game we examine here.

On the other hand, this game had a player who was less experienced with game rules or game cards. Other players had to explain what a certain action entails or details related to card that are played. In the game, Sibella was the least experienced player so other players took their time to read the card text or to explain certain rules in the game.

> S asks why other players laughed after a vampire entered into game. B explains that Maris Streck [a character card in the game] has an ability that changes the table dynamics, as she can burn blood to give anyone intercept. S nods.

As we can see below, 45 clarifications and instructing events were identified during the game and although it is distributed over the course of the game, the densest times are between 40 and 60 minutes.

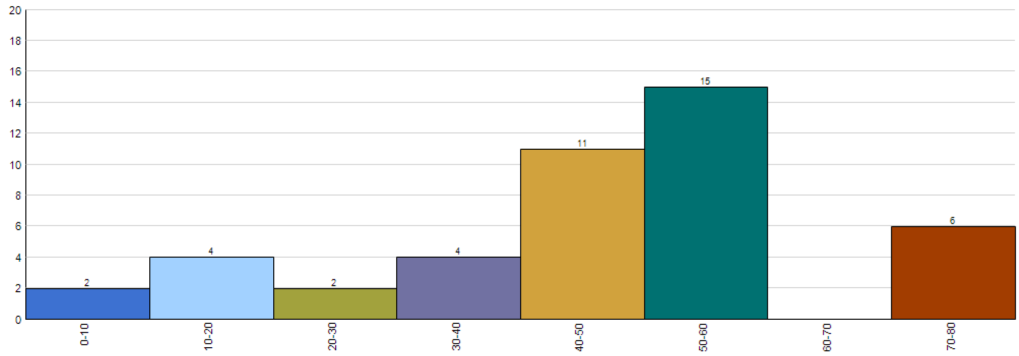

Figure 3: Number of clarifications and teaching took place over the course of the 80 minute game.

Social banter;

Social banter was one of the most prevalent interactions among players. Even though the game was a final table of a championship, players were still telling jokes and acting relaxed as possible.

> J (chuckling)(responding to something S said): I won't be swayed by promises of food. I do love food though.

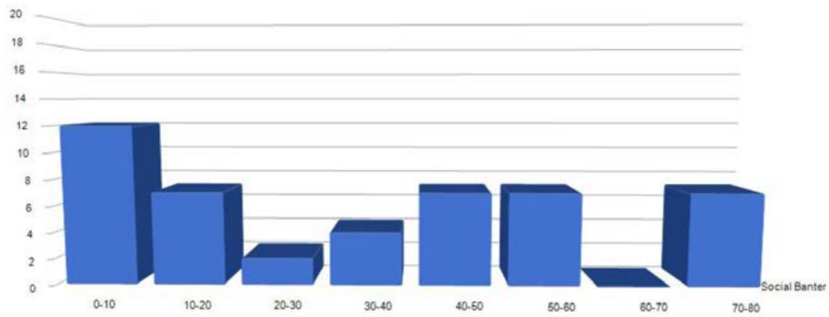

Figure 4: Number of social banter recorded over the course of the 80 minute game.

Reflection on gameplay

Players react and reflect on gameplay after an action or negotiation took place. Some of these reactions were verbal, while some consisted of reflections with body language (e.g., making a sad face). We identify 51 instances of such events. The conversation below took place after J took an action to oust his prey (B) but B deflected his bleed action to R which resulted in ousting R and giving B six more pool.

> R: *Yeah,... You killed me and you gave him a VP.*
> J: *Here's why. He just took a bleed of 5 a minute ago. This would have ousted him, and I would have had 6 more pool.*
> R: *well, you were playing against me the entire game.*
> J: *I was trying to slow you down, I knew that you were fast.*

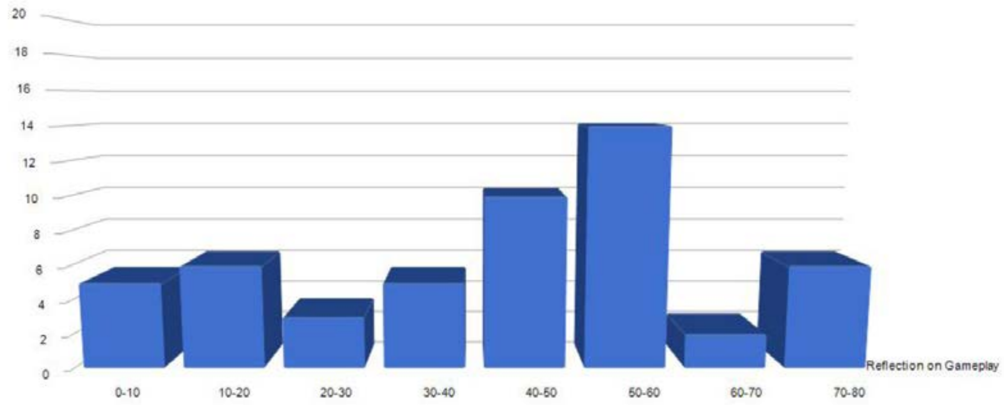

Figure 5: Number of reflection on the game recorded over the course of the 80 minute game.

Strategies

Players many times verbalize their strategies before they act or speculate on other player's overall strategies, sometimes as a way of manipulating other players' decisions. In this game, J was afraid that R would oust S and M quickly and be his predator. In this situation, even if the game timed out (if there is at least 2 players still remaining at the end of two hours), R would win the game because he had the most victory points to play in the final.

> J to S: "*He [R] wants you to soften him [M] up. If you can oust him, great, I don't think he'll stop much*."

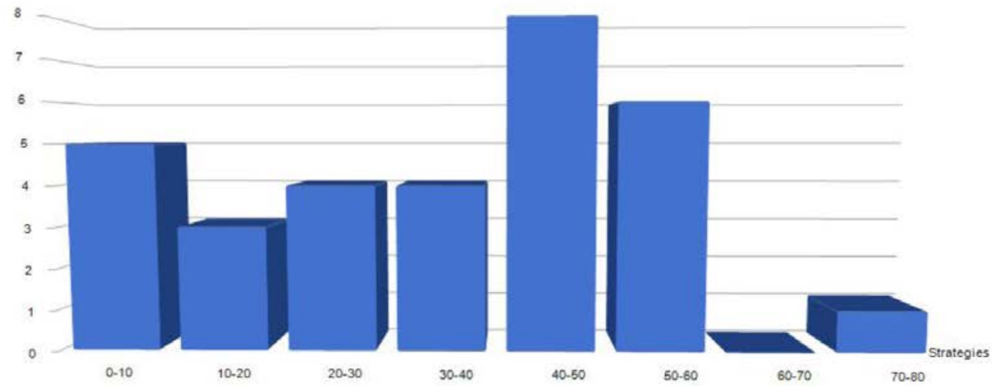

Figure 6: Number of strategies recorded over the course of the 80 minute game.

Out-of-game comments

These were comments about and reactions to out-of-game subjects. There were not many out-of-game comments due to the competitive nature of the game. In a casual game, it is more likely that people talk about out-game topics. There were total of seven out-of-game social interactions. Majority took place in the first half hour of the game.

Encouragement and praise

Players were encouraging each other if there was an action they approved. We identified 16 events in this category.

Complaining

This is one of the common strategies players of V:tes uses. It can be seen as social manipulation. There were 16 events categorized as complaints. It seems that players complain more and more as the game proceeds. After there were only two players left in the game (after 60th minute), no complaints were recorded.

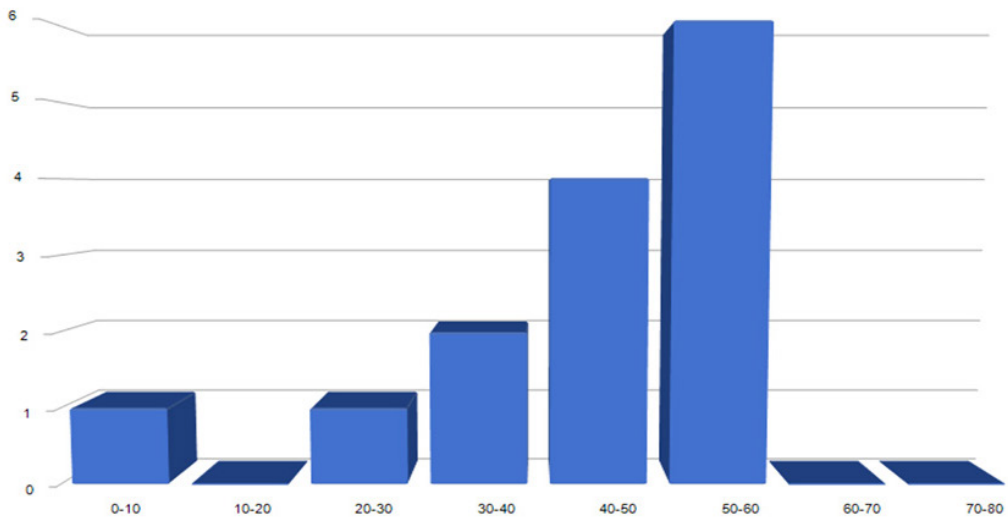

Figure 7. Number of complaints recorded over the course of the 80 minute game.

Design aspects for social interaction

Predator-Prey Relationship

Multiplayer CCGs have different set ups for player interactions other than the emergent interactions that are not designed by the rules. This game setup asks for long term strategy development (within a game).

Chores

Xu et al. (2011) defines chores as "the work necessary to make the play happen in these non-digital games. Players need to update and maintain the game status manually, taking care of rule enforcement and other forms of bookkeeping" (p.3). Chores are the activities that do not specifically require players' decision making.

Chores in V:teS are highly limited, as most aspects of the game involve choice on the part of the player. The only chores that regularly happen are untapping all your cards at the beginning of turn, and adjusting your pool or blood on vampires due to events. Everything else, even though it is mandatory, e.g. declaring whether you're blocking, involves a choice of some sort. Thus they would fall under the heading of game play.

Even altering your pool and blood tends to be so closely associated with in game decisions that it rarely gets talked about in its own right. For example, after declining to block a bleed, a player can still redirect the bleed, or reduce it. Hence, even taking the full amount of a bleed would still fall under the gameplay category. Unless, for some odd reason, the player commented "and now I'm moving the tokens from my pool to the bank..." or something similar.

Conclusion

This paper reported preliminary findings of an empirical study of social interaction in a CCG. Using an inductive analysis method, we identified eighth categories of social interactions. These interactions were mainly facilitated by the designed social mechanic into the game: prey-predator. This mechanics allows players to strategize their actions thinking about long-term (within the game sense) consequences of their actions. For instance, J in this game wanted to balance the game towards his own benefit by denying R a victory point therefore spending his game resources on R who was his second prey and removing him from the game would not give him a victory point. However, because he did not calculate a small detail he ended up giving his prey the game win. The results reported in this paper are based on the video analysis of a single gameplay session. Future studies needed to refine the model with players with variety of experiences.

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Joystick Designs: Middle School Youth Crafting Controllers with MaKey MaKey for Scratch Games

Veena Vasudevan, Yasmin Kafai, Richard Davis, University of Pennsylvania
Eunkyoung Lee, Korea Institute for Curriculum and Evaluation
veenav@gse.upenn.edu, kafai@gse.upenn.edu , richard.lee.davis@gmail.com, eklee76@kice.re.kr

Abstract: While there are many tools for making games, most of these have focused on designing screen interfaces leaving aside the potentially rich space of designing tangible game interfaces. This paper reports on a workshop with middle school youth who created game controllers with MaKey MaKey, a tangible construction kit, to interface with their remixed Scratch games. The analyses focus on the design of game interfaces and programs and indicate that youth mostly replicated common controller designs but varied in their attention to either functionality or aesthetics. The interface designs followed traditional gender lines with girls more focused on aesthetics and boys more focused on functionality and were, to some extent, replicated in the remixes of the Scratch games. In the discussion we address the pedagogical and technological opportunities and challenges of including the design of tangible interfaces in game making for learning.

Introduction

While much attention has been paid to the learning benefits of playing games (Gee, 2003; Squire, 2010), making games for learning has only recently been recognized as an equally productive approach (Kafai, 1995; Kafai & Peppler, 2011). Reviews of game making for learning identify multiple benefits (Hayes & Games, 2008) such as the development of programming skills, integration of academic content topics, and, exploration with systems thinking as youth design interfaces and consider complexities of user interactions. These production-oriented approaches to gaming have also been seen as a means to broaden interest in computing (Denner, Werner, Bean, & Campe, 2008; DiSalvo & Bruckman, 2011). For the most part, approaches to making games for learning have been limited to designing interfaces for screen play, leaving aside the potentially rich learning space of designing tangible interfaces that have gained widespread use with popular game platforms such as the Nintendo Wii™ and Playstation™ Move.

Some, like Bayliss (2007), have argued that tangible control features are an integral part of the gameplay experience, as important as visual and auditory media features. Including tangible control features in game making activities could provide an opportunity to expand the design space from the screen into the physical space, thus introducing budding game designers to some aspects of engineering in addition to programming and interface design. While learning about circuits, crafting, and conductivity of materials adds complexity to the game design process, it also has the potential to enrich the learning experience in different ways. The most obvious benefit is the added authenticity because the appeal of game making activities has always drawn on youths' personal experiences with playing commercially available games. In addition, benefits such as transparency and creativity are equally important. Some have argued that tangible inclusions can add to transparency of computational designs by helping learners better understand the workings of technology (Buechley, 2010) while others see room for creativity that supports learners in becoming more flexible in their technology designs (Smith, 2006).

In this paper, we set out to investigate the potential for authenticity, transparency, and creativity in tangible game design by setting up a workshop in which youth designed game controllers for Scratch games. The recent development of tangible interface construction kits (TICKs) has opened the possibilities for novice programmers to create their own physical controller designs (Millner, 2010). One example is MaKey MaKey (Silver et al., 2012), a small USB device that connects to conductive materials and transforms them into touch-sensitive buttons that can control and move objects on the computer screen. The following research questions guided our analyses: What kind of tangible interfaces would youth create for their games? How would beginning programmers deal with the complexities of coordinating the virtual and tangible designs of their games? What would reflections reveal about the young designers' experiences? In our discussion, we discuss the pedagogical and technological opportunities and challenges of tangible game making for learning.

Background

Over the past decade, the number of available game design tools has jumped dramatically (Burke & Kafai, in press). Numerous game design platforms have been developed, ranging from specialized tools to open-ended programming languages. Building on Resnick and Silverman's description of computational construction kits (2005), Burke and Kafai distinguish between two major types of game-design platforms: those with wide walls and those without. They define wide walls as the capacity of a tool to allow for a variety of creations, in this case, a wide variety of games. For example, Sploder is a game design platform that does not have wide walls, as it restricts the types of games users can create to four genres: platforms, puzzles, shooters, or algorithms. Although these more specific tools limit the variety of games users can create, they also provide a lower barrier of entry that is attractive to designers with limited experience. In contrast to these narrowly-focused platforms, Scratch is an example of a platform with wide walls that allows beginning designers to create many genres of interactive media, including stories, animations, and games. While game making activities have become quite popular, few efforts include the design of tangible controllers such as joysticks or touch pads, most likely because the technical and material components are not easily accessible.

In recent years however, a number of different TICKS have been developed that can be used by novice designers to craft their custom interfaces (Millner, 2010). Like the game-design platforms, these TICKs can be grouped by either specific or general purpose. Specific-purpose construction kits limit the user's options as a way of reducing complexity and lowering the barrier of entry. One example of this kind of kit is the Lego WeDo, which can only be used to create controllers that sense tilt or distance. As an additional restriction, these controllers can only interact with a small number of applications. More general-purpose construction kits such as the MaKey MaKey allow for the creation of a wider array of tangible interfaces that can be used with a larger number of software applications. By expanding game design for learning to include tangible interface design, we build on this rich tradition that is an integral part of gameplay (Bayliss, 2007). What can we expect to gain by giving youth the ability to design and construct interfaces to go along with their games? Though there are a handful of studies that describe interface-design courses (Martin & Roehr, 2010), none of them examine the benefits and challenges of this activity. While children as designers of tangible interfaces has not been studied, there are studies of children as users of tangible interfaces. Horn, Crouser, and Bers (2012) compared learning with tangible interfaces to more traditional methods and found that tangible interfaces are more inviting, better at supporting active collaboration, and, have broader appeal across genders. However, they also found that tangible interfaces are not easier to understand or more engaging than graphical user interfaces. This ambiguity may stem from the fact that introducing tangible interfaces into the classroom increases the complexity of not only the activity but also materials involved in the design.

Most relevant to our study is Millner's (2010) research on 'hook-ups' that illustrated how youth can craft various tangible interfaces with found materials. The recent development of Makey Makey (Silver et al., 2012) provides an example of construction kit that can be used with any type of conductive material. Due to the popularity of new gaming platforms, designing tangible interfaces for games is a meaningful extension within the context of gaming literacies. Salen's (2007) work on gaming literacy illustrates the range of knowledge and skills that youth need in order to be able to be successful game designers ranging from system-based thinking and interactive design to game logic and rules, and, programming skills. When considering tangible user interfaces within the context of gaming literacies, it is evident that these designs also lend themselves to the creative, iterative and complex thinking that are required of game designers and connect to current efforts to promote computational thinking (Brennan & Resnick, 2012; Pea & Grover, 2013). However, it is unclear how the addition of tangible activities to an already complex design process plays out with younger designers and how it connects to the design of the digital game itself. The current study is a first effort to see how game design can be extended from the digital to the physical through the design of tangible interfaces.

Participants, Context & Approach

Participants and Setting. This study took place at a K-8 neighborhood school, situated in a metropolitan city in a northeastern state of the United States. Students in 6^{th}–8^{th} grade chose this workshop for a short-term elective that met twice a week, for 50 minutes. A group of nine youth (4 boys, 5 girls, ages 11-12 years) participated in the game design workshop, but only six consented to research. The workshop was co-taught by three of the authors.

Game Design Workshop. Youth were asked to remix existing Scratch games and design their own interface using a MaKey MaKey kit (see Figure 1). In the first three workshop sessions the youth were introduced to the Scratch environment, the MaKey MaKey, and the basics of creating circuits. In the next three sessions they spent time modifying (remixing) their games. After selecting a specific game to remix for their final projects, youth designed physical interfaces using Play-Doh and materials such as pipe cleaners, aluminum foil, metal tape and wire. In the final three sessions youth developed and tested their interfaces.

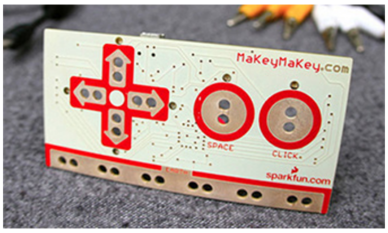


Figure 1: MaKey MaKey Tangible Interface Construction Kit.

Data Collection and Analysis. We documented workshop activities, group interactions and design work in observation notes, photographs, and video recordings. In addition, we collected the youths' interim and final programs. The variety and use of computational concepts (such as loops, conditionals, events) in youths' Scratch programs was analyzed using a framework developed by Brennan & Resnick (2012). In addition to computational concepts, they define computational practices such as remixing and debugging and perspectives such as connecting and questioning, that when brought together describe the knowledge, actions and ideas that embody computational thinking. We captured the progress of youth's game controller designs with photos. The game controllers, designed with the MaKey MaKey construction kits, were analyzed with respect to functionality and aesthetics. We also conducted post interviews with youth in which they reflected on the their design processes and approaches while looking at their Scratch programs and images of their game controllers. The interviews were coded using a two-step process that identified two themes: audience considerations when designers referred to players and device creation when designers reflected on the challenges and benefits of creating their own controllers.

Findings

All youth expressed surprise and excitement about creating their own tangible game interfaces. The most striking moment was when they connected for the first time their game controllers to the actual device and played games with their own controllers. In the following sections, we present what we learned about their (1) design of game controllers, (2) programming of games, and (3) reflections on designs and learning.

Designing Game Controllers. All workshop participants were successful in designing operable game controllers with MaKey MaKey and Play-Doh, but their designs differed in functionality and aesthetics (see Figures 2-3, a-f). The first group of controllers was mostly functional in nature: James used large buttons and explained that the smaller Play-Doh 'buttons' were to help the user's fingers grip them more easily while Marcus created four smiley faces, which were large enough for a user to place their hand on but, more importantly, easy enough to play his game. In contrast, Ethan used pipe cleaners to create a hand-held joystick and Play-Doh mounds as the touch points to complete the circuit for his game controller. His design stands out because he decided to incorporate pipe cleaners to emulate an existing type of game controller. Ethan mentioned in the post-interview that he what he liked about his design was that it was "unique from the other projects because I have a different kind of controller."

Figure 2: Game controllers designed by James (a), Marcus (b), and Ethan (c).

The second group of youth game controllers was functional as well, but showcased more aesthetic features by incorporating into their designs graphical elements of the Scratch program (see Figure 3). Two girls chose to recreate the specific characters (sprites) in their Scratch programs as elements of their game controller designs. While Isabel matched the details of the sea creatures in her Fish Chomp controller to the sprites in her game, as did Ishita for her Penguin Game, Amani used the colors of her sprites to inspire her controller design for the Zombie Game. She used pink to represent the brains and green to represent the Zombie's skin, also taking time to include the directionality of the buttons on her controller (e.g. right, left, up, down).

 d.	 e.	 f.

Figure 3: Game controllers designed by Isabel (d), Ishita (e), and Amani (f).

In designing their game controllers, youth dealt with challenges in creating and using them. Most youth had a hard time working with alligator clips and getting them into the small holes on the MaKey MaKey. Depending on how youth designed their interfaces, the alligator clips would occasionally fall out of their touchpad components, which resulted in having them stop play to reconnect their devices. In addition, some youth connected multiple parts of their controllers, thus causing short circuits. When this happened we reminded them about the principles of circuits and they made adjustments to their controller designs. Finally, students sometimes found it difficult to hold onto one alligator clip connected to the ground section of the MaKey MaKey, so we devised a solution by helping them to craft conductive bracelets out of tape or Play-Doh that they could wear while playing their games.

Designing Scratch Game Programs. All youth remixed the program code of selected Scratch games by adding elements such as a score, bad guys/distractors, or new ways to win the game. The analysis of final Scratch code indicated that youth used a wide range of computational concepts (Brennan & Resnick, 2012): all projects used sequential statements, five youth used loops, four youth used conditional statements and variables, and three youth used event handling and operators. Some youth also spent time rethinking the aesthetics and front-end aspects of their games by making changes to the main characters (sprites), drawing backgrounds, and, adding sound effects. These remixes in Scratch code replicated what we observed in the design of game controller: a difference in attention to functionality and aesthetics. Two case studies illustrate the range of efforts in adapting aesthetics (Ishita) and functionality (Marcus) in screen and tangible designs.

Ishita chose the *Monkey Game* as a starter project (see Figure 4). She spent considerable time on transforming the aesthetic design of the Monkey Game. She spent one class period to identify images on the web and modify them for her game, eventually selecting a penguin to replace the monkey and fish to replace the bananas. She also drew a background to go with her theme using the paint editor in Scratch. Once the aesthetics were complete, she turned her attention to modifying two aspects of the game dynamics. First, she added a shrinking piece of ice to the game so that the player had to eat all the fish before the ice melted. She also modified the code to include background music and sound effects whenever a fish was eaten.

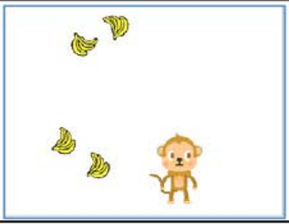
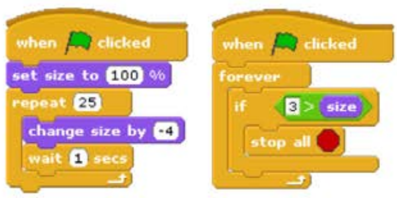
Ishita's Game Design			Code for Melting Ice
	→		

Figure 4: Ishita's game screens and sample Scratch code transformations.

To remix the starter project Fish Chomp*,* Marcus focused on finding a way to win or lose the game (see Figure 5). To win the game, Marcus changed the functionality so that the hungry fish (the main sprite) needed to reach a size of 105. Each time the hungry fish ate a smaller goldfish, Marcus incremented both the physical size of the fish and the score variable. However, if the hungry fish touched the killer seaweed before it reached the size of 105, then the player would lose the game. In addition to these changes, Marcus also switched control of the fish to the arrow keys (from the mouse), added sound and animation effects each time a goldfish was eaten, and had the hungry fish share the words "You win!" if the player met the conditions for winning or "Game over" if the hungry fish ran into the seaweed. The only aesthetic change he made was to add the killer seaweed sprite.

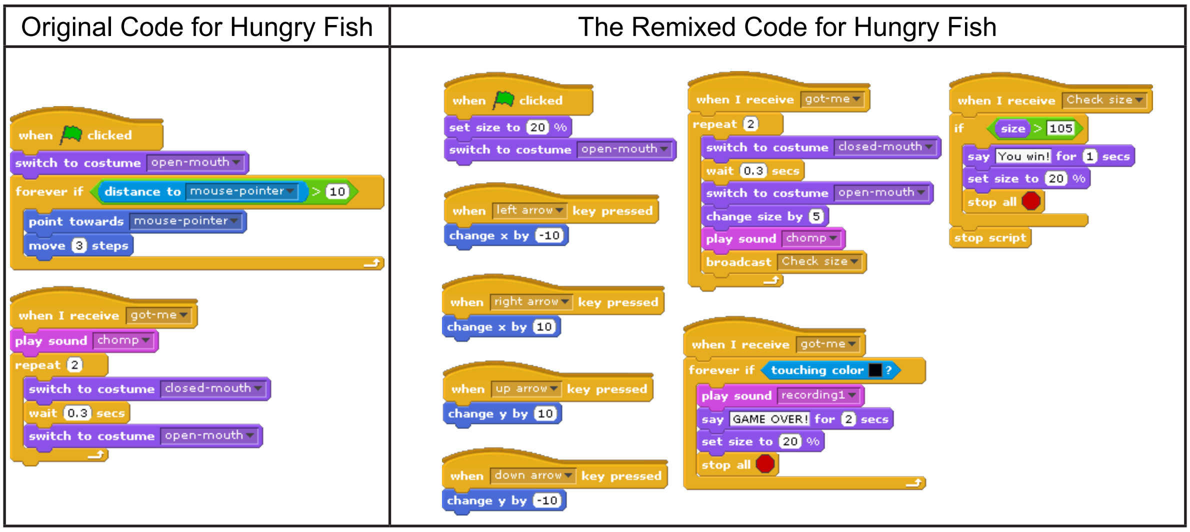


Figure 5: Marcus' Scratch screen and code transformations

Reflecting on Tangible Designs. Two themes—audience consideration and benefits of controller design—were prominent in youths' interviews. All youth referred to their Scratch programs and game controllers in relation to an intended player by mentioning "someone who might play" or "player". For instance, James reflected, "I think it's good, because it's pretty basic, if uh, like, like, in most games, like, there's like, in the arrow keys and space bar and that kind of stuff. So I, so I didn't really want to confuse the play- the person that's going to play." Amani, explained how her interface would be easier for her first-grade sister to use because the buttons are easier for younger kids to navigate: "Cuz she has to look up and down, but with the interface, she just goes like this (gestures by moving her hands to four spots on table). And it's like, she can use her whole hands, at some point her hands will be big enough to do it, but sometimes, right now, her hands are a little bit too small. So, with the interface, she can just put her whole hand on it. And it would just be fun and it wouldn't get her as frustrated." Reflections like these indicate how authentic game design experiences, both on and beyond the screen, provide youth with more opportunities to consider audience as they step into the role of a designer.

Another prominent theme in participants' reflections was the satisfaction in their ability to create their own controllers. Referring to a video that was shown at the start of the workshop and illustrated different applications of MaKey Makey, James said, "And at first, I didn't, I didn't know, I thought they were just like making it up or something, thought it was like special effects. But like, at the end, I knew that they were, like it was actually real." Others, adopted a DIY mentality and relished the opportunity to make their own devices: "Umm, so, umm, when I heard of it, I was like, it's so much better than using a regular keyboard, like a regular keyboard. It would be awesome, if we could actually use them like everyday. Like an everyday kind of thing. That would be cool too." Similarly, Ishita expressed what she thought the benefits were of designing game controllers: "I think this is better, because if someone was like going somewhere, and say their keyboard broke or something, they could just use MaKey MaKey and that thing, the thing they made, to make a keyboard..." Here, she is noting the flexibility that MaKey MaKey affords designers and users.

Discussion

In this study, we added the design of tangible interfaces to game making activities for learning. Our goal was to understand youths' creations, approaches, and perceptions as well as associated challenges and opportunities when game design moves beyond the screen. We observed that youths' tangible interface designs mostly replicated common controller designs—perhaps not a surprising finding given the personal experience that most young designers bring from playing console games at home. What varied though was attention to either functionality or aesthetics in their controller designs. We saw striking differences in how youth mapped out their physical designs ranging from unformed heaps of Play-Doh to carefully designed controller spaces. An unexpected finding was how these different approaches to controller design followed traditional gender lines, a pattern that was to some extent replicated in the remixes of youths' Scratch games. While the demographics of gamers have significantly shifted in the last decade to include more girls and women players (Kafai, Denner, Heeter, & Sun, 2008), it still remains a heavily segregated community, especially when considering technical production—the context of our study. While we do not want to overgeneralize these findings based on a small group of youth, such striking differences might point to different expectations and informal experiences that need to be considered when incorporating tangible design activities inside and outside of schools.

Functionality and aesthetics are important principles that need to be negotiated in every design, whether for the virtual space of the screen or in physical space of a controller or in conjunction with both, as it was the case in our study. One could argue that the challenge to both designing physical controllers *and* remixing a game were too challenging for novice designers. We tried to mitigate this by providing youth with starter Scratch games that they could remix or repurpose to their liking and develop controllers to fit their games. Youths' reflections revealed clear consideration for audience in the design of both their Scratch games and controllers. By no means are these considerations a trivial finding as we have found in previous studies (Kafai, 1998). For designers, it is difficult to shift perspective and take into account how someone else might approach playing a game. Designing a tangible interface, a touch pad or joystick in this project, made the different perspectives more apparent. Most importantly, youth moved beyond their perspective as designers to reflect on their understanding and knowing of technology, connecting their design experiences to everyday interfaces. This aspect most clearly connects to the 'transparency' argument developed by Buechley (2010) and others that illustrate how engaging learners in making technology artifacts can lead to understanding about functionality and design. The excitement and sense of accomplishment related to designing their games and controllers, expressed by participating youth, spoke to these aspects of transparency.

Less prominent in our study were creative variations on controller game designs. While all youth came up with unique controller designs, only one participant went outside of replicating the standard design of *up, down, right, and left,* arrow keys. Their lack of experience in working with computational construction kits is one likely explanation for this. The inclusion of material components adds another layer of complexity and requires an understanding of material science that few youth have. While many DIY activities aim at bringing back these types of hands-on manipulation and learning (Honey & Kanter, 2013), they are rarely encountered within the school context; robotic construction kits being the one exception but these are often inaccessible to youth due to cost and complexity. There are various ways in which we can think of broadening youths' approaches and perceptions of what a tangible game controllers can be or could look like might and result in more dynamic controllers. If future MaKey MaKey kits came with a collection of different switches and sensors, that could broaden the interface design possibilities achievable right out of the box. For example, pressure switches could be used to create touch-sensitive floor mats, or photoresistors could be used to add motion sensing. The inclusion of such parts could facilitate particular constructions without limiting the expressiveness and simplicity of the MaKey MaKey. This may also help when it comes to working with youth on usability design. Instead of spending time simply attending to detailed replications of their sprites, we want to get youth to think about how a particular design can make it easier to play certain games. To that end, in future iterations, we want to consider including some more interface and usability design as part of the instruction. We also want to give youth more time to iterate on their designs, so they can engage in a cycle of build, test, tweak. Ultimately, we want youth to move beyond and experiment more with conventions, not just to increase their understanding of technology but also to foster more creative and critical approaches to the design of everyday things. Participating in such design experiences will open a world of opportunity in gaming and computing, but also has potential to go beyond these genres.

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Augmented Reality and Neighborhood Narratives

LeAnne Wagner, Independent Design Consultant, leannemwagner@gmail.com
Ingrid Erickson, Rutgers University, ingrid.erickson@rutgers.edu

Abstract: An increasing number of people are utilizing their smartphones to craft mobile, geo-located stories and games. Many avail themselves of authoring tools such as 7scenes and ARIS, which allow authors to create end-user experiences that run like locative apps on most devices. While these experiences can be both novel and enjoyable, they can require specialized knowledge to use fully and are dependent on GPS-infrastructure that is not always accurate. This paper explores an alternative to crafting mobile narratives that exploits the idea of digital-physical "seams." We report on a series of design and playtest activities that build off of the augmented reality application, Aurasma, and theorize how using augmented reality in a game design curriculum can support both pedagogical as well as creative ends.

Introduction

There is no longer any contestation that technology is having a fundamental impact on the contours of learning in the 21st century. We now have decades of research that showcase the affordances of computer programming, video production, game design and play and other mediated forms on engagement on how, why and when learners learn (Kafai, 1995; Gee, 2007; Steinkuehler, et al., 2012). The advent of 'participatory culture', noted by Jenkins (2006) as the ability for people from all walks of life with a network connection to add, augment or author some type of digital data and share it with others, has altered how we think about mediated forms of learning. Much of the early work on computational thinking emphasized the move from analog to digital; yet as digital has moved to the level of invisible infrastructure, the shift in the age of participatory media is also moving from individual to social, and from user to collaborator. Digital forms of production and engagement are not only ways for individuals to tackle problems and challenges for their own knowledge acquisition, but also to air those understandings before others for comment or other forms of social uptake (e.g., Barron, et. al., 2010).

Participatory culture and its correlate forms of learning have been known to emphasize the role of narrative. Writing, filming or drawing stories allow learners many degrees of freedom to express their insights and air their inquiries. In the day and age of sharing one's productive efforts, stories are also well suited as readymade packages with which others can comprehensively engage and react. The genre of a story is recognizable and approachable, whether it is delivered as a graphic novel, a prose poem or an uploaded video. Moving stories from the desktop to the street—made possible by the advent of ubiquitous and accessible mobile technologies—need not change how stories are produced, but it greatly affects how they are consumed. Any New York subway rider will tell you that a smartphone, a good game or video app, and a pair of headphones can separate you powerfully from even the thickest crowd of straphangers. In this way, mobility provides ubiquitous accessibility—small enough to fit in your pocket and ready wherever you are.

Yet mobile-enabled stories can also be powerfully present in a different way in geographic space. Here mobility allows for the broadening of 'hybrid' possibilities, namely bringing a digital layer to physical space where none was possible (or inconvenient) before. Most hybrid forms of mobile engagement leverage a device's locative capabilities using something called Assisted GPS (aGPS), which triangulates a location based on the known spatial coordinates of a set of cell towers. The end result is a fairly accurate pinpointing of longitude and latitude, enough for a device to run and utilize map features regularly. In response to these technical capabilities, we have seen a corresponding rise in the use of cartographic visualization by apps and other media—particularly in applications that allow users to create locative stories and games, such as 7scenes or ARIS.

Locative storytelling applications share some common features. As seen in Figure 1a and 1b below, these applications generally allow a user to 'place' a storytelling element at a specific geographic location using the applications' cartographic interface. For example, if the story creator wants something to happen at the corner of Broadway and 37th Street, she need only place a story element at that location using the map interface; once the player moves into that geographic area, his device will appropriately alert him. In applications like 7scenes and ARIS, a creator can place a variety of different kinds of story elements, including digital images, videos, and user-generated instructions, such as answering a question or choosing from a set of pre-arranged activity options.

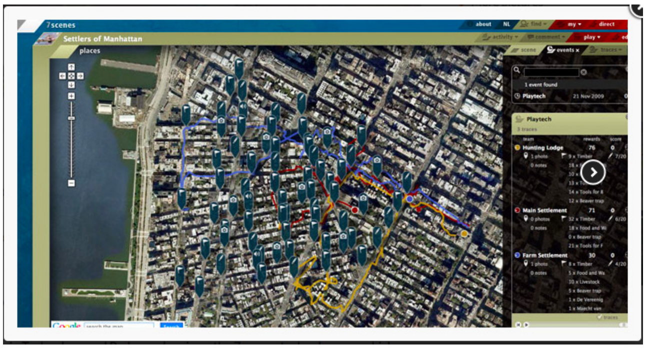

Figure 1a: Authoring screenshot from 7scenes website.

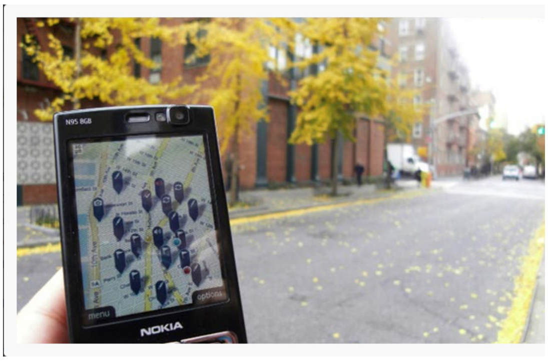

Figure 1b: Play screen from older version of 7scenes application.

The application 7scenes, designed by the Waag Society in the Netherlands, allows users to build their own stories with the use of set of genre templates such as tours (i.e., discovery, guided tour, and mystery search) and games (i.e., adventure, collect & trade, secret trail, and free play) so that the story's designer can spend less time on the technical detail and more time with narrative generation. University of Wisconsin-Madison's ENGAGE (http://engage.wisc.edu/) program has produced a similar product called ARIS, which has similar functionality to 7scenes but is notably distinct for being open source. ARIS's designers tout heir tool to be a "user-friendly, open source platform for creating and playing mobile games, tours and interactive stories" (http://arisgames.org/). Like its cousin application, ARIS also allows users to build their locative narratives by using a map interface (see Figure 2), but does not leverage existing narrative categories to guide the user. In keeping with its commitment to openness, users creating stories using ARIS have a fair degree of freedom to create game or story elements from scratch and to program their functionality with the application's story editor.

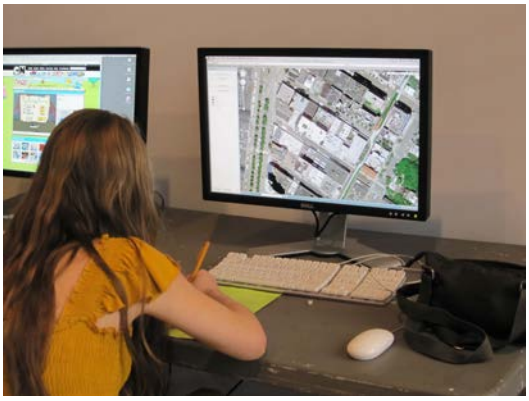

Fig. 2: Map-based interface of ARIS authoring tool.

Both of these applications, as well as the other similar applications that have recently entered the market, exemplify the potential for mobile learning to be an embodied, situated experience in geographic space as mentioned above. Each of these tools brings an aspect of digital media into context when it is 'played': what might otherwise be salient but abstract information when read or experienced on a computer screen can become something potentially more impactful when consumed or engaged with on location.

Despite this potential, we contend that the zeal for new forms of mobile learning might be eclipsing the need for learners to translate abstract spatial dimensions in order to use the standard cartographic interfaces of many available applications. Our research suggests that youth today have little familiarity with maps and cartographic ways of thinking, despite the seeming ubiquity of this form of information nowadays. This lack of spatial and/or navigational literacy, while notable as a goal for future pedagogical initiatives, inspired us to find a workaround for youth that could enable them to leverage their storytelling and game design enthusiasm without the need for abstract spatial translation. We report there on early playtests with the application Aurasma in an informal learning context in urban Cincinnati.

Playing the Neighborhood with Augmented Reality

The hallmark of a great situated game or narrative is that it transforms the street or neighborhood into a three-dimensional game board. Exemplars of this genre abound, ranging from big urban games such as Human PacMan and PacManhattan to more bounded learning experiences focused on the ecology of a city (e.g., Mannahatta) or the simulation of a rampant virus (e.g., Humans vs. Zombies). In addition to being immersive, interest-driven experiences, successful mobile narratives also encourage situated forms of learning (Klopfer, 2008; Squire, 2013), as mentioned above.

We first began to experiment with mobile alternatives to ARIS and 7scene by using QR codes—the increasingly ubiquitous two-dimensional barcodes that enable a smartphone user to unlock a piece of digital information such as a photograph, text message or hyperlink in a particular location. Our experience with youth revealed that QR codes are somewhat irresistible in a "bright, shiny object" sort of way; they beckon to be unlocked and their secrets to be revealed. They also function independently of GPS, which in many urban contexts is less accurate than in more open spaces, while still marrying information to place. The downside of QR codes in urban contexts is their lack of durability. They are typically printed on paper or a sticker and, as such, are prone to defilement, theft or removal, or—most typically—inclement weather.

Similar to the functioning of a QR code, Aurasma (http://www.aurasma.com/) is a mobile, augmented reality application that allows a storyteller or game designer to attach a digital piece of content to a real world marker. This is similar functionality to Layar and Google Goggles. A storyteller need only identify something in the physical world to act as a trigger for her narrative, and when a player views this trigger through the mobile device, a video or image appears on screen. The marker/trigger can be anything the user photographs and assigns ahead of time. (See Figure 3 for an example.)

Figure 3: Using Aurasma app to add augmented reality elements to embodied interactions. Here Big Ben acts as the trigger to reveal a flying car in the London sky.

Over two successive weekends in May 2013, we ran a workshop to playtest a modified version Aurasma with 10 kids from an urban Cincinnati afterschool program. We followed a game design curriculum that progressively moved the participants from playing board games to designing neighborhood-based narratives. Narratives were based on the concept of urban legends, and all participants readily identified 5 locations in the immediate neighborhood across which they wanted their situated experience to unfold.

Implementation was challenging due to infrastructure unpredictability (not atypical and not something that can ever be wholly relied on), but nevertheless participating youth teams produced two games. One team focused on writing elaborate clues and story integration, while the other team concentrated on making a seamless digital prototype. Under time constraints, neither team achieved full integration of their game, but nevertheless both reached a stage where they could play test one another's creations. Play testing allowed the design teams to identify successful design choices as well as areas for improvement.

Our preliminary findings using Aurasma to scaffold narrative game design and situated learning experiences suggests that augmented reality has a strong affordance for supporting creative expression *in situ*. To our participants, the ability to create digital content—as well as the unique trigger for initiating that content—appears to provide strong authorial agency. Our game designers and storytellers seemed to see spatialized opportunities for engagement in a direct way that required little two- to three-dimensional translation. Using augmented reality required kids to not only think about how to move a player to the next location, but also forced them to think through what actions were needed to help the player locate the pre-identified AR trigger. This area of engagement is rich with further questions regarding the links between creative agency, situated learning, and geo-spatial literacy—a trajectory our future work on this project will hopefully begin to disambiguate.

While we are certainly not the first to claim a link between learning and augmented reality (e. g., Klopfer, 2008 being an important contribution in this space), we less often see either QR codes or augmented reality used in the service of mobile game design *by youth* instead of mobile game design *for youth*. As we complete this research, we will look to open up a more substantive discussion regarding how digital augmentation can support youth-led forms of situated engagement, social interaction and creative expression.

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Augmented Reality Games in Education

Deidre Witan, Harvard Graduate School of Education, deidre_witan@mail.harvard.edu

Abstract: Augmented reality technology is a powerful tool for student learning that is made even more effective through the interactivity of games. This paper compares six case studies that exemplify the medium's educational strengths, each representing a different method of interacting with augmented reality technology. Best practices for using augmented reality games to teach abstract concepts (by visualizing arithmetic), scientific inquiry skills (by diagnosing a failing ecosystem), design thinking (by planning a city), and creativity (by creating a game) are also discussed. However, inadequate research, limited teacher training, and the challenge of obtaining funding for new equipment pose challenges to implementing this new technology in schools. Until augmented reality becomes more commonplace outside of schools, its impact on formal education will be limited.

Introduction

Augmented reality allows teachers to create lessons that cross the gap between abstract concepts and real life. It can demonstrate impossible things and still situate them within the context of a classroom or field trip. Teachers can use augmented reality to simulate a conversation with a historic figure, the effects of a toxic chemical spill, or motion in a frictionless environment. In the author's experience, teachers' responses to demonstrations of educational augmented reality have been highly positive. They immediately get excited about the possibilities for using this new technology to demonstrate difficult concepts like gravity or scientific inquiry. The fact that the virtual images are contextualized means that they are very accessible and invite both teachers and students to "come play!" Augmented reality is only going to get more sophisticated and ubiquitous, and teachers should be able to harness these developments to help their students learn in fun and engaging ways.

However, when an augmented reality app isn't interactive, it's little more than a video. For example, *Aurasma*, an augmented reality application that is becoming popular with teachers, features on its website images that will trigger video responses on a handheld device (Aurasma, 2012). However, since the original image is already on a computer screen, it actually would be easier to just put a "play" button on the image to start the video. Whereas there is some potential for application if the images were a hard copy (at a museum, for instance) the real power of augmented reality comes when students begin interacting with both the virtual and real worlds. Video games can provide that interactivity, as well as provide a structure for learning.

The unique way augmented reality combines the real and the virtual creates an immersive experience for the player, enhancing the gaming experience and increasing student engagement. James Paul Gee (2007) has identified 16 characteristics of video games that make for excellent educational experiences. Many augmented reality games have some or all of these characteristics, but the unique medium enables them especially to excel in situated meanings: the ability to relate academic concepts to real-life understanding. Textbooks and other traditional tools have trouble with this since they are isolated from real contexts. Video games do better in that they relate meaning to in-game situations. However, augmented reality games can relate meaning directly into the real situations students are dealing with – whether it's a pond, a historic marker, or their own school.

According to the New Media Consortium (2012), augmented reality is four to five years away from widespread adoption in schools. This paper looks forward to some of the technological advancements that will make it much easier for teachers to create augmented reality lessons, and even create their own games. There is much potential for using this exciting new technology to improve education, and this paper provides a broad look at the options that are currently available. Both benefits and drawbacks of the technology are discussed, and educators are encouraged to consider how the unique affordances of augmented reality technology can complement their current curriculum.

Benefits of Augmented Reality Games

Augmented realities facilitate the visualization of abstract concepts.

Fetch! Lunch Rush is an arithmetic game from PBS, available to parents and kids in the iPhone and iPad app store. It provides students with 3D visualizations of math problems as they go through the game. This game is based on fiduciary markers that show up as 3D sushi within the app. *Fetch! Lunch Rush* helps kids prepare for algebra by strengthening the connection between real objects and abstract symbols (PBS Kids, 2011b).

Another example of this visualization aid is *SciMorph*, a 3D character who teaches elementary school students about science concepts like gravity, sound, and germs. Students print out a fiduciary marker, hold it up to the webcam, and view both themselves and SciMorph on the screen. Through augmented reality, students are able to manipulate physical forces in ways that are impossible in real life. Students can use *SciMorph* to investigate the effects of different levels of gravity and sound in ways that would be challenging to simulate even in a physics lab. (United Kingdom Department for Education, 2010).

Although everything SciMorph does, like jumping up and down or sneezing, can be expressed in a 2D video, the interactivity and non-linear structure of the game increases student engagement in the material. According to the International Center for Leadership in Education (2008), active learning strategies that require interactivity are significantly more engaging than videos and other traditional media. They recommend that teachers vary their instructional methods to incorporate many types of interactive media.

Augmented realities are uniquely suited to teaching scientific inquiry and problem-solving.

EcoMobile, an augmented-reality project at the Harvard Graduate School of Education, addresses the challenge of teaching scientific inquiry, not just scientific facts. Students are presented with an ecology problem during a field trip to a local pond environment, and are tasked with finding the cause and proposing a solution. As students explore the pond, they encounter “hotspots” where virtual information is available via fiduciary marker. They can use their handheld devices to take water quality measurements, interact with fictional characters, or explore microscopic processes. Students interview virtual characters, gather data, review documents, and ultimately form and test a hypothesis. However, there is no one right answer – students are assessed on their process and reasoning, and create a video to share their findings (Dede, Grotzer, Metcalf, & Kamarainen, 2011). According to the National Academy of Education (2010), these sorts of open-ended questions encourage the kind of complex thinking that adolescents need to develop their inquiry skills. They warn that if students are given problem-solving tasks that are too simple, they will not develop necessary complex thinking skills or an appreciation for science. Although students are unfamiliar with these kinds of open-ended problems, they tend to enjoy those discussions more. According to a high school engagement survey, 65% of students agreed that they “like discussions in which there are no clear answers” (Indiana University - Bloomington School of Education, 2010).

Teachers have been very supportive of the *EcoMobile* project, reporting higher student interaction and collaboration, as well as a deeper understanding of ecological principles, than seen on typical field trips (Kamarainen, et al., 2012). As one sixth grade teacher said, “I felt like it gave them a different ownership over the experience than if there had been just one teacher voice and a crowd of kids…My students were psyched about molecules, too…all that world unseen, all that new stuff is making them feel much more like this is real science or adult science. A bunch of my students are hooking into science in a way that they report that they never have before. I can’t help but think that the high-powered technology helps” (Dede & Grotzer, 2012).

Augmented realities encourage open-ended play and design thinking.

Augmented reality games allow students to explore relationships of objects and situations that aren’t easily accessible to them in the real world. A great example of this is the *Star Wars: Where Science Meets Imagination* travelling museum exhibit. The exhibit is a Star Wars-themed urban planning puzzle game. Players are given puzzle pieces printed with fiduciary markers. When placed on the game board, the puzzle piece appears as a 3D building on the display screen. As players move the pieces around, they can rearrange the configuration on the screen. The game introduces principles of urban planning in a familiar and fun environment (Rodley, 2008).

By eliminating the constraints of reality, students are able to experiment with their own designs and quickly discover the results. Moreover, this game also provided students with a tactile connection to the systems they were building, allowing them to manipulate the virtual elements in the same way as they would real objects.

Google’s *Field Trip* app is a great example of how this technology can be used for more ubiquitous informal learning outside of museums. This smartphone app runs in the background as users go about their day. When they pass by something interesting, the app alerts them to what’s nearby and provides information about it (Niantic Labs @ Google, 2012).

The free-play nature of both *SciMorph* and *Field Trip* allow students to move at their own pace, draw connections, and learn through experiencing different perspectives. Although the two programs are very different in content, medium, and audience, they both provide students with the freedom to explore topics in ways that would be impossible in a traditional classroom setting (United Kingdom Department for Education, 2010; Niantic Labs @ Google, 2012). All three of these examples embody constructivist principles of allowing students the time and freedom to discover and create meaning for themselves.

Augmented realities facilitate active learning through creativity.

Mansel Primary School in Northeast Sheffield, UK addressed the challenge of teaching creativity and design by having students not only play augmented reality games, but create one of their own. The *Imaginary Worlds* project started by having students play *inviZimals*, a commercial augmented reality game for PSP, to introduce them to augmented reality. Afterward, students created their own games by designing virtual locations, linking them to fiduciary markers, and placing those markers at locations around their school. Then, fellow students could go on quests to these locations using camera-equipped PSP devices (Fletcher, 2011).

The *Imaginary Worlds* project engaged students in active learning by emphasizing the process of generating new knowledge rather than facts or even understanding. By focusing on the process of creation, students were encouraged to take active control over their own learning and create links with past experiences. One student displayed this sort of deep thinking about the project when he reported thinking through what his imaginary world would smell like so he could choose images that would evoke the same feeling (Phillips, 2010). Although active learning can take place in many venues, studies have shown that the act of creating their own video games and other media can result in improved student outcomes (Farrell, 2009).

Augmented reality games are fun!

According to Raph Koster, fun is defined as “the feedback the brain gives us when we are absorbing patterns for learning purposes.” The challenge in designing learning games is to keep the patterns just difficult enough that the players remain interested (as cited in Kirkley & Kirkley, 2005). Many commercial video games are already designed with this in mind – levels get progressively harder, and players can purchase or find items in the game to make challenges easier when necessary. In this way, video games are set up to keep the player constantly within their own Zone of Proximal Development, at least as it relates to their gaming skills (Puentedura, 2010). In fact, in interviews students report specifically seeking out video games that are challenging, and enjoying repeating levels until they were mastered (Gumulak & Webber, 2011). Designers are harnessing this power when creating video games that provide “just-in-time” help and scaffold instruction in the various levels of the game (Gee, 2007).

Barriers to the use of augmented reality games in school

Teacher professional development

Although technologies like augmented reality can spark excitement about its potential, they can also incite worries about implementation. A major barrier to widespread adoption is that many teachers are hesitant to change their teaching style to include any kind of technology, but especially games, in their classrooms (Dunn, 2012). Since there is so little up-to-date research on educational video games, teachers can be skeptical about using games in their classrooms (Online College Courses, 2012). The research on augmented reality games in education is currently very weak because the games being studied are mostly unavailable to the general public. The games that teachers easy access to, such as those being sold in app stores or those being offered through education companies, have very little research demonstrating their efficacy. More research is needed to evaluate commercially available augmented reality games.

Teachers are also concerned about the transfer of skills from video games to real life (Online College Courses, 2012). However, using augmented reality in educational games can help bridge that gap by placing the game in context within the real world. Teacher Karen Schrier accomplished this with her game *Reliving the Revolution*, a location-based history RPG about the Battle of Lexington. The game was set at the actual battlefield, and her students played roles as period-accurate characters as they attempted to solve the real-life mystery of who fired the first shot. Schrier reported that the experience was positive and more effective than a typical field trip to the battlefield, and she encourages other teachers to try similar games with their classes (Schrier, 2006).

Classroom management is always an issue for teachers, and they especially have difficulty monitoring students as they go through video games at their own pace (Online College Courses, 2012). However, many games address this issue by allowing students to repeat sections, ask for help, or skip through to a harder level. In addition, when students are engaged in a learning game, the off-task behaviors that require constant monitoring are typically diminished. Continued training can help teachers develop a new classroom management style that accommodates the presence of video games in the classroom.

Many teachers are unaware of the augmented reality games that are currently available, and aren’t prepared to use them effectively in their classrooms. More professional development is needed to provide teachers with the support they need to effectively use augmented reality games.

mplementation issues

The cost of the technology is major barrier for many schools - 50% of teachers say this is the top reason they choose not to use video games in their lessons (Online College Courses, 2012). This is especially challenging for augmented reality games. Because handheld technology is developing so rapidly, the devices schools purchase will become obsolete in a few years. Until video games have solidly established their educational efficacy, many schools will continue to prioritize other expenses.

Additionally, implementing augmented reality games in a school environment can be very labor-intensive. Often two or three facilitators are required to set up the game, make sure the devices work properly, and address any problems that arise. The games also often rely on the expertise of a skilled teacher to help students make connections to previously leaned material (Dunleavy & Dede, n.d.).

Finally, many schools that regularly use handheld devices for learning do so as part of a “Bring Your Own Device” (BYOD) program. However, this means that students’ devices will have varying age, type, and operating system. Since most augmented reality games are not available on all platforms, even schools that are already using handheld devices will have difficulty implementing these games as part of the curriculum (New Media Consortium, 2012).

Unfortunately, there is no clear-cut solution to the problems of funding in education. However, many schools have been able to overcome these difficulties and successfully implement a mobile learning program. The Consortium for School Networking provides some recommendations to schools that are starting a mobile learning program, which can help ease some of these implementation pressures. They recommend a variety of creative professional development opportunities, robust wireless internet connection throughout the school, and a focus on improving teaching and learning through the technology. Schools that apply these recommendations will be in a much better position to use the augmented reality technology that is available now, as well as set themselves up to take advantage of future developments (Gray, 2011). More and more schools are investing in technology as studies continue to show increased achievement in math, literacy, and reading when teachers integrate technology into their lessons (Common Sense Media, 2010).

Conclusion

The augmented reality games presented here were chosen as examples of six different ways of using the technology. There are many more quality games available to teachers and researchers, but they will typically fit one of these six broad types. The games generally fall into two categories based on how they combine real and virtual information. One type consists of small, simple games that can be used anywhere on a smartphone or other handheld device. These games use fiduciary markers or GPS location to provide players with the virtual images (see Table 1). However, this type of game is limited in its scope and its ability to create an immersive environment. Examples include *SciMorph* and *Fetch! Lunch Rush!* (United Kingdom Department for Education, 2010; PBS Kids, 2011b).

The second type is large, event-based games that require extensive setup. These are often created using handheld devices like a smartphone or PSP (see Table 1). Players are restricted to a designated play area that is specially prepared for the game using markers or GPS coordinates. The extensive setup makes it difficult or impossible to play these games in another location (Broll, et al 2008). *EcoMobile* is a great example of this type because it requires the setup of hotspots at a local pond (Kamarainen, et al., 2012). Other games are restricted to one specific physical location, either by GPS coordinates within the game, or, as is the case with *Star Wars: Where Science Meets Imagination*, because it is housed within a museum exhibit.

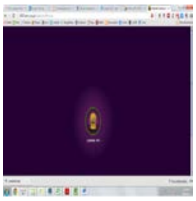
<table>
<tr><th></th><th>Webcam</th><th>Handheld & Markers</th><th>Handheld & GPS</th></tr>
<tr><td>Ubiquitous</td><td>
SciMorph</td><td>
Fetch! Lunch Rush</td><td>
Field Trip</td></tr>
<tr><td>Event-based</td><td>
Where Science Meets Imagination</td><td>
EcoMobile</td><td>
Aurasma</td></tr>
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Table 1: Types of Augmented Reality Games

(United Kingdom Department for Education, 2010; PBS Kids, 2011a; Niantic Labs @ Google, 2012; Discovery Science Center, 2011; Dede, C. & Grotzer, T., 2012; Aurasma, 2010)

The small, simple augmented reality games like *Lunch Rush, SciMorph,* and *Field Trip* have the potential to have a transformational impact on education in the future, when augmented reality technology is more commonplace. As the technology improves, and as wearable devices become more user-friendly, augmented reality as a whole will become ubiquitous in areas with the infrastructure to support it. Increasing dependence on augmented reality and other technological advances are likely to have a transformative effect because teachers will have to give up some measure of control in their teaching styles. In structured lectures, where teachers are the only authority in the room, they don't have to have a complete understanding of the topic – they only have to understand what's in the lesson. Augmented reality and other tools that allow students to explore beyond the confines of a structured lesson will lead students to ask questions beyond the scope of a teacher's preparation. Because of this, teachers will have to shift from *having* all the answers to the role of a guide helping students *find* all the answers (Dede, 2012).

However, the impact of all augmented reality gaming will be limited until augmented reality technology becomes commonplace outside of school. There is not much evidence that schools will be early adopters of this technology, and there is little incentive for developers to create entire curricula around augmented reality games (New Media Consortium, 2012).

Finally, in the future we will see more and more teachers like Karen Schrier designing and creating their own augmented reality games. As the technology improves, so do the tools for creation. Right now, teachers are using *Aurasma* to create their own learning experiences for their students (Aurasma, n.d.). *Aurasma* is a platform similar to the popular augmented reality web browser *Layar* in that it provides location-based information using GPS. However, it is unique in that users can create their own "Auras" and share them with others. These auras can then be viewed by any smartphone that has the *Aurasma* app installed (Aurasma, 2012). *Aurasma* is highly versatile and customizable, and innovative teachers have found it to be useful in creating their own immersive environments or scavenger hunt games on their school's campus. For this reason, I've included it as an event-based game, although there are certainly other ways to use this app. (Aurasma, n.d.). In addition, since *Aurasma* is free and easy to use, teachers are also using it to help students build their own augmented reality projects (Noonoo, 2012).

The use of *Aurasma* as a creative tool points us toward the future of augmented reality – when designers and teachers hand off the creation process to students so that they can learn not only as consumers of the technology, but also as designers. We teach students to read, but then we also teach them to write. We teach them to appreciate art, and also to paint. Students are already starting to use augmented reality on their smartphones and video game devices – now it's time to teach them how to create exciting new games using this technology.

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Symposia

Beyond Badges & Points: Gameful Assessment Systems for Engagement in Formal Education

Barry J. Fishman, University of Michigan, fishman@umich.edu
Sebastian Deterding, Hans Bredow Institute, s.deterding@hans-bredow-institut.de

Abstract: This symposium brings together a range of gameful assessment designs at different levels of formal education to explore how gameful design might lead to greater student engagement and improved learning outcomes. We use the term "gameful assessment" to describe assessment frameworks or approaches that employ game design principles to foster student motivation and learning. The symposium examines systems in both K-12 and higher education, and considers both the conceptual underpinnings of these systems and the design space of current tools developed to make it easier for instructors to implement gameful grading systems. Data related to the success (and struggles) of each system will be discussed.

Introduction

There is no question that well-designed video games are powerful learning environments (Gee, 2003; Squire, 2011) that motivate players and keep them engaged throughout ever-increasing challenges. Recently, the lessons to be learned from good video games have been extended beyond the *literal* design and use of games for learning to the use of *game design principles* to conceive of a different way to organize instruction, turning formal education itself into a game-like experience (Deterding, 2012). Instead of playing video games in K-12 or college classrooms, or learning through the engagement in the practices, affinity spaces, and larger ecology of video gaming (Salen, 2008; Squire, 2006), the idea is to use game design principles to create a gameful framework for learning and teaching. One common industry term for this approach is "gamification" (e.g., Kapp 2012); we prefer the phrase "gameful design" to avoid the charged connotations gamification, and to signify a wide focus on the full palette of game design to create gameful experiences for learning. These might include design methods and models, like play-centric design, or game design principles like "clear goals" or "supporting autonomy" – rather than a narrow focus on a small set of interface design patterns (points, badges, etc.) commonly associated with "gamification" (Deterding, Dixon, Khaled, et al., 2011). As many critics of the 2011-2012 "Badges for Lifelong Learning" DML Competition have noted, the 'standard' commercial points-and-badges implementation of gamification often replicates rather than transforms traditional grading systems, inadvertently replicating their shortcomings as well, such as a focus on performance metrics rather than learning and mastery (e.g. Reid, 2011) and an over-reliance on extrinsic rewards that can decrease deep and lasting engagement.

Indeed, a significant challenge in changing school practice is the inertia that comes from many directions, especially from students, who have grown used to the traditional approach to grading and other course structures. As Davidson (2012) frames the situation:

> [Our students] were well taught and learned well the lesson implicit in our society that what matters is not the process or the learning but the end result, the grade…. where "success" has been reduced to a score on a test…. The message we're giving our students today is all that really counts is the final score. (Davidson, 2012)

One criterion for the success of gameful approaches to educational design is that the problem is alleviated rather than exacerbated. Current work is happening at various levels of intensity and scale, with whole schools like Quest2Learn (Salen, Torres, Wolozin, et al., 2011) representing the upper end of the spectrum. Restructuring at the level of individual classrooms often represents the vanguard of experimentation, as instructors have substantial control over their local teaching choices. An early and prominent example of this experimentation is a 2009 university course on the theory and practice of game design taught as an MMOG (Sheldon, 2011). Many found this example to be intriguing, and set out to try variations on it themselves. These efforts often employ, either implicitly or as explicit design strategies, core motivational theories such as goal theory (Linnenbrink & Pintrich, 2000) or self-determination theory (Ryan & Deci, 2000).

As many within the education community experiment with these techniques, the time is right to gather together several different examples in order to evaluate whether, when, and how these designs translate into more motivating and therefore more successful learning environments. In short: *Can the design methods and principles that work to motivate players in games also motivate learners in typical classroom instruction – not just within discrete topics but at the level of an entire course, or an entire program or school?* Specifically, this symposium focuses on the gameful design of *assessment systems* as part of larger learning designs. The use of game design to motivate learners goes beyond ‘just’ assessment (O’Mahoney et al., 2012), but since assessment systems provide a strong framing element for the broader learning goals of formal education, we believe they provide a good entry point and focus. The symposium includes examples from both K-12 and higher education. It also includes some emergent technological tools that are intended both to embody gameful course designs and to make them easier to enact. An explicit goal of this symposium is to bring key issues in course design to the surface, leading to an elaborated research and design agenda to inform future progress.

Mapping the Design Space of Assessment Forms in Gameful Classrooms: Rationales, Patterns, Issues, Solutions

Sebastian Deterding, Hans Bredow Institute, s.deterding@hans-bredow-institut.de

In recent years, a sizeable number of educators across settings and age groups have experimented with re-designing the whole classroom experience in the image of well-designed video games. At the 2008 GLS Educator’s Symposium, we conducted a one-day workshop convening 13 educators with experience crafting their own “gameful classroom” in order to facilitate the exchange of best practices and lessons learned, and to build a grounded understanding of current practices and problems. The workshop, together with follow-up surveys and interviews of further creators of gameful classrooms, revealed an astounding variety of designs, sometimes inspired by Lee Sheldon’s *The Multiplayer Classroom* (2011), sometimes independently bootstrapped solutions.

Several initiatives are currently on the way towards developing software platforms to support and scale such gameful design approaches across a larger number of classrooms, specifically gameful assessment frameworks (e.g., Fishman & Aguilar 2012; classrealm.com). Arguably, the design of such platforms should be informed by the experience of existing practitioners and designers, and start from an informed understanding of the total set of current solutions. To enable knowledge exchange between current practitioners and system designers, and to build a foundation for systematic research, this presentation offers a mapping of the design space of assessment forms in gameful classrooms, based on inductive coding (Schadewitz & Jachna, 2007) of interviews, taped moderated discussions, document and interface analyses of a total of 23 gameful classroom designs. The mapping is organized in three interlinked parts:

- **Rationales**: All surveyed educators have strong reasons for ‘daring’ to deviate from standard educational practices. These reasons inform the specific design solutions they devised, and the specific solutions are seldom understandable without knowing their rationale. We sketch the various rationales active in gameful classrooms, linking them to existing discourses and theories in game-based learning and learning theory.
- **Design Patterns**: Using (game) design patterns (Björk & Holopainen, 2005) as an analytic lens and organizing concept, we will describe the different forms of gameful assessment we found, and how they link to the underlying rationales.
- **Issues and Solutions**: We will outline the most common assessment-related challenges educators reported when implementing gameful classrooms, and solutions they found.

The final section of this presentation will explore patterns we found to be consistent and consistently reported as successful (e.g. emphasis on formative assessments, increased autonomy and reduced threat of failure through unlimited redoing and task options, turning ‘gaming the system’ into an explicit part of the course design), outline existing families or ‘ideal types’ of design approaches, draw recommendations and caveats for system creators, and describe further research needs.

Motivating K-12 Math Students with Special Needs with MathLand

Kate Fanelli, Beacon Day Treatment Center, katefanelli@gmail.com

I teach Algebra 1 and 2 to students with severe emotional impairments. Although my students receive special education services, they are on a diploma track and accountable for the same skills and credits as their general education peers. They work below grade level in mathematics (average grade level is 10.2, average achievement level is 5.5) and have significant gaps in learning. My students are generally capable students who are unable to function in school because of their emotional issues. This manifests itself through school or work avoidance, acting-out behaviors, lack of focus, learned helplessness and/or poor relationships with school personnel. 87% of students at my school receive free or reduced lunch. 90% carry a psychiatric diagnosis, and 68% take medication(s). 25% of our students have a history of court-involved placements or interventions.

In teaching these students, I struggled with continuity (attendance is a major problem), skill mastery (the tendency was toward work production rather than learning), and motivation (students showed minimal motivation to do endless piles of work). I wanted students to be more self-directed, independent, and focused on forward movement and skill development. A solution was to re-design my classroom using a game-based approach, which I call "MathLand." I use a cycle of formative assessment, self-assessment, and summative assessment to help students learn, check for their own understanding, and demonstrate both long and short-term mastery. Points are awarded for passing mastery tests, and final grades are based on number of points earned. The system is reinforced by the use of student avatars, which earn status and track student movement on an avatar board that is displayed in the classroom.

The curriculum is split into "levels." Students begin at level one and work until all levels are completed or until the school year ends. If students earn 100 points in one marking period, they enjoy free time until the new quarter, or keep working and get a head start on the next quarter. One junior finished an entire course early and had the opportunity to begin her senior math class or be a teacher's assistant for the last marking period. She worked hard to learn the curriculum because she wanted to finish the course, be the first student to finish so quickly, and choose how to spend the rest of the school year. Her accomplishment is legendary and frequently recounted by newer generations of MathLand students. Levels have three parts. The "lesson" has explanations and a few exercises. "Practice" is optional. If a student does not feel ready for the mastery test after the lesson exercises, or repeatedly fails the mastery test, he/she may choose to do practice problems until ready to continue. The "mastery test" is completed independently and must be done 100% correctly to pass. Students also take a summative assessment as a pre-evaluation and then at the end of each of four quarters to show long-term gains and retention.

My presentation will describe basic elements of the program (alignment to standards, lesson/practice/mastery), the grading system (cumulative point system), and assessment mechanisms (formative and summative). I will discuss effective motivating elements, and game design elements I use to maintain student engagement and program structure. I will discuss pros and cons of this program, implications for instruction and classroom management, and present anecdotal and statistical evidence of the program's success.

Gaming on the Ground: Assessment at the PlayMaker School

Lucien Vattel, Tanner Higgin, Katerina Schenke, GameDesk
lucienvattel@gamedesk.org, tannerh@gamedesk.org, katerinaschenke@gmail.com

Launched in September 2012, the PlayMaker School is an attempt to infuse a sixth grade curriculum in Los Angeles with play, making, and discovery-based activities. In this sense, it is one of a handful of attempts to make games and game-like elements a fundamental part of the classroom experience (e.g., Salen, et al., 2010). These attempts are motivated by the potential of games to motivate, engage, and facilitate deep, conceptual learning, and exploration of complex systems (Klopfer, Osterweil, & Salen, 2009). Mindful of the fact that games are not the perfect tools for every situation, the school is also interested in tracking the learning circumstances and outcomes suited to games and play (Squire, 2011). In this context, a question of great importance becomes: What does game-based learning and assessment look like when not an exception but a common practice, and how does it work over the course of the year, and throughout all content areas in a functioning school? In our presentation, we outline specific challenges, and solutions we have iteratively developed, including a larger assessment framework, as well as specific assessment strategies designed to better capture learning with games.

Over the course of the past year, through pilot studies of educational games and curriculum in after-school programs, we have found that one of the greatest challenges facing game-based learning in classrooms, and gameful curricular design, is designing and employing assessment approaches that both facilitate student learning and adequately capture that learning (Vattel & Riconscente, 2012; Vendlinski, et. al., 2010). It's not enough to integrate games into traditional classroom approaches, because familiar assessment approaches often inadequately capture or outright misrepresent game-based learning; rather, we need radical new means of assessment to be built and used in conjunction with new playful classroom activities. At our school, this assessment framework manifests in curricular and assessment design, course management, and teaching practice.

Tackling this issue directly, we've developed processes and tools to help researchers and educators capture observations and design on-the-spot and extended assessments around emergent learning experiences. Our approach—developed iteratively and through collaboration between researchers, educators, administrators, and curriculum developers—consists of a "character sheet" which allows students to be assessed formatively and tracked across a range of non-traditional measures, a modular "adventure map" that dismantles the class period structure blending disciplines and allowing differentiated student pathways, and a "learning tool" course management system designed at New Roads School which captures and orchestrates the curriculum in our school.

Beyond these larger-scale initiatives, we've found a need for philosophical and conceptual changes at the pedagogical and curricular level. Educators need to articulate broader learning outcomes and cognitive processes, and to situate and classify these around particular emergent activities within the school, and to view student learning as developing slowly over time rather than in discrete situations. We've seen in our school, and within our curriculum development sessions, how educators aware of these concerns can build, refine, and share rubrics, assessment frameworks, and facilitation techniques for effective integration of physical and/or digital educational activities.

One example of how assessments around a game have been developed in this context is *Newton's Playground*, a digital physics sandbox game and open design environment that requires players to "draw in" machines (levers, pulleys, and springs, etc.) in order to move a ball across a series of obstacles (Shute & Ventura, 2013). In *Newton's Playground*, students have an opportunity to discover physics concepts such as conservation of angular momentum, torque, and potential and kinetic energy. There were no available assessment approaches for this game, or any similar physics sandbox style game. Consequently, we designed a set of assessment approaches unique to the learning process witnessed in the game. These strategies include talk-aloud sessions that extract vocabulary from the player during play, assessment through public and private exhibition of play strategies, problem solving of challenges both solo, in pairs, and in small groups, and annotation, review, and reflection of video captured play.

With these on-the-ground and on-the-spot educator strategies, placed in conversation with the larger assessment structures in place at our school, we hope to provide a model from which to discuss not only how games fit into the classroom, but how we can design assessment frameworks and practices that appropriately work from what games do well, and what students and educators do with them.

Competition + Collaboration: Keys to Intrinsic Rewards in Higher Education

Lee Sheldon, Rensselaer Polytechnic Institute, sheldc2@rpi.edu

It is not enough to simply change letter grades to experience points, or offer extrinsic rewards such as leveling, badges or leaderboards. As in any good game design, it is essential to celebrate the social aspects of multiplayer gaming, and build them into any assessment system.

When I designed my first multiplayer classroom in 2009, I first concentrated on a simple mapping of game elements to instruction and learning. But game design is a process of iterating, testing, then iterating again. It became clear as that class progressed that there were several elements that worked particularly well: grading by attrition, learning by failing, but most importantly the social interaction multiplayer games provide. This presentation will detail how outcomes and assessment evolved hand-in-hand to create a super-charged atmosphere of engagement that produced almost perfect attendance, higher class grades, and deeper retention of subject matter. Following are some examples that will be explored during the presentation.

Dividing students into guilds allowed them to both compete with other guilds and also collaborate. I began simply with a secret ballot peer review that allowed guild members to offer input on how well they felt their fellow guild mates were doing. I used random dice roles to challenge guilds. I began designing exams with a section of questions which, if answered by any guild member, all members received credit. Most enlightening (and fun) were exam prep classes designed as competitions between guilds where again guild members could individually help their guild mates. Soon, emergent behavior appeared. In one case students found "better" ways to compete under the competition's rules. Two other examples involved guilds that were doing better on the prep competition, helping weaker guilds so everyone could win that game. Later, during a class teaching Mandarin Chinese, students again, of their own volition, collaborated to play the game on a more complex level than I had designed. What occurred was not some students using the assistance as a crutch, as I had at first feared, but *all* students doing much better when assessed. Woven through the presentation is the narrative of how my own learning was enhanced by the depth of the students' engagement; the ways in which they made the classes their own; and my seriously tardy realization of the importance of sustained narrative in what I now think of as "collateral learning." I'll introduce a new class teaching engineering called "These Far Hills," the saga of a multi-generational Irish family emigrating to the New World: Mars. I am a writer. I should have known this from page one!

Proceduralized Gameful Course Design with Queso

Clayton Ewing, University of Miami, c.ewing@miami.edu

When we constrain ourselves to a set of rules, the choices we make are guided by the imposed system. This effect can be productively used in the design of "white label" learning platforms: By following a design-based research paradigm (Wang & Hannafin, 2005), I created a learning management system (LMS), named Queso, that adheres to a rigid gameful implementation. Therefore, any classroom using my software is guided by principles based on the experiences of myself and other users of my LMS in creating a gameful course. This presents an opportunity for instructors not well versed in gameful design to easily adopt these principles as a means of introspection to challenge the "traditional" model of pedagogy and allow for new models to emerge.

The software is built as a three-tier system composed of quests, skills and grades that mimic traditional role-playing game (RPG) leveling systems. An instructor starts by determining the skills a successful student should have when they complete the course. For example, a journalism instructor might value integrity, writing and research. Quests incorporate the various skills for the class: an article might be awarded points for Writing and Research while an in-class discussion of an article increases Integrity. Finally, an instructor chooses point thresholds for grades that are assigned to their lowest skill level. This approach encourages students to be well-rounded rather than excel at one particular skill. It also frames the course as a heroic effort of amassing enough points to achieve an A rather than not losing enough points to receive a failing grade.

Whether submitted digitally by the student or by the instructor, all quests are tracked within the software, which provides basic gradebook functionality for instructors and assignment tracking for students. The information is constantly shown to the student as a progress bar to increase their motivation (Lewis, Wardrip-Fruin, & Whitehead 2012), as well as letting each student be constantly aware of their standing in the course. The quest data is also visualized through charts and lists of completed assignments with instructor feedback for improvement. Allowing for the benefits of self-paced learning (Tatum, 2012) unattempted quests are presented to the student providing them with an opportunity to choose what interests them at that moment. The software does not confine an instructor to due dates and as a result quests do not need to be mandatory. A superfluous amount of quests can be created and provides a student multiple paths for achieving a top grade.

A central premise of video games is the freedom of failure. Once submitted, a quest does not end. By creating a psychosocial moratorium on quests, students don't have to fear receiving a bad grade (Gee, 2003). A student can attempt a quest as many times as they want during the course in order to achieve a higher skill point total. Borrowing from the ideas of boss battles in games, quests can also be set to only allow students of a certain skill level to attempt them. The student practices with small quests and is rewarded with a big skill boost when completing a master quest.

This software has been used in various educational settings for courses on math, programming, visual design and game design. Once a course is created, an instructor can iterate upon its design by adding new quests as well as modifying and removing old ones while they slowly perfect the classroom experience. With further research, we hope to expand the types of courses taught and examine the metrics behind those courses to find ideal scenarios for gameful classrooms.

GradeCraft: A Tool to Support Gameful Teaching & Learning

Barry Fishman, Caitlin Holman, Stephen Aguilar, University of Michigan
fishman@umich.edu, cholma@umich.edu, aguilars@umich.edu

Gameful assessment systems are potentially motivating for learners, but also potentially challenging for instructors. Part of the challenge is related to the change in approach; new or different pedagogies present challenges to teachers who are used to organizing instruction and assessment in a particular way. Pedagogies that present more choice to learners and result in a broader variety of representations of learning, such as many gameful approaches, are naturally more complex and more difficult to manage than "traditional" didactic pedagogies (e.g., Crawford, 2000). And there are additional questions about *what design elements* (and in *what combinations*) in gameful approaches are most likely to be effective in motivating learners. How does one strike a balance between the extrinsic motivation that is typical of standard assessment approaches (Jürges, Schneider, Senkbeil, & Carstensen, 2012; Shepard, 2000) and the more desirable intrinsic motivation that gameful approaches are thought to inspire (Connected Learning, 2012)? Is it possible to design a Learning Management System (LMS) that increases students feelings of autonomy, belonging, and competence — all key elements of self-determination theory (Ryan & Deci, 2000)? If so, will this invariably lead to improved student motivation? To explore these questions, we constructed a LMS to both support the implementation of and support research on gameful approaches to teaching.

Our gameful LMS is designed with the goal of supporting grading systems that give learners more choice and control over pathways towards accomplishing course goals, and providing greater feedback to learners regarding their progress towards those goals. On the instructor side, our LMS also makes it easier for teachers to monitor the progress of individual students and groups of students, to organize and support both collaborative and competitive work, and to provide feedback on assignments that are linked to different kinds of recognition for student work. In its most basic form, the tool can be thought of as a replacement for the assignment and gradebook tools that are central components of typical LMS environments. We conceptualize the process of building this tool as a design-based research endeavor (Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003), both extending the theory of how to support learner engagement through the structure of the course grading system and assignment structure, and supporting empirical research to better understand how the system can be improved through iterative design (e.g., Fishman & Aguilar, 2012).

A central feature of our design is the "Grade Predictor," a visualization that lets students examine the points (grades) they have received in the course, and then literally "game the course" by exploring various pathways toward their desired final score or course grade. Students can compare their progress to classmates' progress, viewed as a box and whisker plot of the mean, median, and range of progress both overall and on individual assignments. We hypothesize that the Grade Predictor increases students' agency in the course by making the consequences of different choices clearer, encouraging students to experiment with different learning opportunities and assignments. Other features of GradeCraft include a framework for creating, awarding, and displaying, badges (Hickey, 2012) as a part of the assessment environment; tools for the interpretation of learning analytics data (both for instructors and for students); tools to support the formation and management of teams (both instructor- and student-determined); and assignment creation, collection, and grading tools, including rubrics that are linked directly to badges and point determinations.

We have examined the use of GradeCraft in several different university instructional settings, including large lecture-style courses and smaller seminar courses. We are interested in studying the use of GradeCraft in a broader range of courses and will do so as we refine both the tools and our understanding of how the design and use of the tools are related to greater student engagement in general as well as greater student feelings of autonomy, belonging, and competence in particular.

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Blazing New Ground in Informal Education: Integrating Mobile Augmented Reality Games in Unlikely Places

Judy Perry, MIT
Bob Coulter, Missouri Botanical Gardens
Renata Pomponi, Kris Scopinich, Mass Audubon
Rhys Simmons, Old Sturbridge Village

Abstract: Informal learning institutions are seeking new ways to integrate mobile technologies which offer visitors unique educational experiences. One way to do this is with augmented reality (AR) software, which allows players to use location-aware smartphones to play games featuring a digital overlay within a real-world context. AR experiences can highlight and contextualize ideas, while personalizing the visitor experience. This panel discussion features three distinct informal learning institutions (a wildlife sanctuary/working farm, a living history museum, and a botanical garden) each of whom recently developed and piloted its own AR game using TaleBlazer (an augmented reality authoring toolkit for iOS and Android smartphones). The panel session will include a brief overview of TaleBlazer, case studies of the pilot projects developed by each institution, and dialogue between panelists and the audience on the unique challenges of integrating AR in unlikely informal learning places.

Background:

Over the last decade, as mobile technologies have proliferated the consumer market, their ubiquity has begun to offer "just in time" educational possibilities previously unavailable to the general public. Visitors to informal learning institutions, pursuing spontaneous autonomous threads at their own pace and from their own unique perspectives, can use smartphones to access information about a given topic (object or place), contextualize and "curate" objects within broader themes, and individualize their experiences based on personal interests. Data from 2012 suggests that 45% of adults (Rainie, 2012) and 31% of 14-17 year-olds (Lenhart, 2012) now own smartphones, a trend spurring institutions to develop digital materials which capitalize on BYOD opportunities to offer individualized interactive experiences for their visitors. For informal learning environments, especially those whose experiences are highly immersive and generally "low-tech" by their very nature, the challenge arises in integrating the benefits of technology in a pedagogically and contextually sensitive way. This panel will explore the challenges and opportunities faced by three relatively "low-tech" informal learning institutions seeking to offer a particular BYOD approach, specifically augmented reality (AR) software, into their visitor experience.

Panel participants include:

1. MIT Scheller Teacher Education Program: a research lab developing and researching Augmented Reality software platform. *(moderator)*
2. Old Sturbridge Village: a living history museum recreating life in rural New England between 1790-1830.
3. Drumlin Farm Wildlife Sanctuary: a working farm and wildlife sanctuary promoting an awareness of the interdependence of people, land, and wildlife through environmental education, stewardship of regionally significant habitat, and sustainable agricultural practices.
4. Missouri Botanical Garden: a center for botanical research and science education in St. Louis, Missouri.

The panel session will be structured to give the audience a window on the work being conducted at each site as well as the opportunity to participate in a discussion of broader themes of augmented reality and informal learning. The session will be structured as follows:

- introduction to AR (generally) and TaleBlazer software *(5 minutes)*
- each institution's brief case study of an AR implementation pilot project, and its challenges *(10 minutes per institution, total 30 minutes)*
- questions from moderator for panelists *(10 minutes)*
- questions from audience for panelists *(15 minutes)*

TaleBlazer Software and Prior Research

Augmented reality (AR) provides users with a digital layer of information within an existing real-world context. As players move around the real world, their location-aware smartphones trigger interactions with virtual characters, objects and data. AR games often utilize a narrative structure to contextualize content, and can allow players to take on "roles" to jigsaw information among players and support positive interdependence (Klopfer, 2008). Augmented reality games are not domain-specific, and cover subjects as diverse as the American Revolution (Shrier, 2005), the illegal wildlife trade (Perry & Nellis, 2012), and political protests on college campuses in 1960s (Squire, et al., 2007)

A small number of AR toolkits exist which allow designers to create or modify their own AR games. Players can then download game files to their mobile devices to play location-based AR games in real-world locations. In this growing space, software including 7Scenes, ARIS and FreshAiR allow non-programmers to create (and play) their own location-based AR experiences. For the past decade, MIT has been among those both developing AR games and its own AR authoring toolkits, as well as conducting research evaluating best practices and seeking to understand the affordances and limitations of this evolving technology within an educational context.

The newest version of MIT's software, TaleBlazer, diverges from previous software and others in this space with its use of a blocks-based programming language (cf. similar approaches in Scratch or StarLogo). The blocks-based scripting language provides AR game designers with a high degree of flexibility with which to embed models and complex game mechanics into their games. The goal is to enable the design of rich, dynamic games which (1) allow *authors* to craft experiences which closely align with the pedagogical goals of the institutions and (2) allow *players* to participate meaningfully within the games, taking actions and then seeing how their choices influence the game.

The efforts described by panelists extend closely related prior work in this field. Earlier research done in collaboration with the Missouri Botanical Garden demonstrates that students were able to make and play AR games in a semi-structured out-of-school settings. Research done in collaboration with the Columbus Zoo & Aquarium also demonstrated that youth who played educational AR games as part of a field trip shifted their views on issues (e.g., global climate change) as a result of playing an AR game compared to a comparable control group (Perry & Nellis, 2012). However, little research to date has evaluated the impact of AR games offered to "casual visitors" at informal learning institutions. In what ways can AR games impact visitors to informal learning environments? How do AR games differ among audiences of different ages (young children, teens, and adults)? How do visitors experience AR games within an "unexpected" context of a nature center, botanical garden, historical village, etc.?

AR Pilot Research Projects

In Fall 2012, MIT partnered with two institutions with long traditions of location-based informal learning. The goals of this collaboration were close partnerships to develop and pilot games for new locations, new audiences, and new approaches to utilizing the scripting capabilities of the software. In addition to this pilot work, MIT and the Missouri Botanical Garden also embarked on a new NSF grant, iCSI (informal community science investigators), aimed at engaging youth/families in AR games (and youth in AR game creation) at informal science institutions to promote public understanding of science, the role of informal learning institutions, and interest in STEM.

In designing AR games to engage visitors, each of these informal learning institutions faced a number of challenging questions, ranging from the most basic (What is the game about? Who is the target audience?) to the logistical (What real-world locations, animals, plants, objects or people will be part of the game? How long is the game? How large of a physical space does the game utilize?) to the more nuanced (How does a digital mobile game fit within the existing context of the institution? What style of game makes sense? What are the risks of using this game and how can they be best anticipated?).

The pilot institutions within this panel also share an interesting challenge in that each relatively "low tech" in two ways: (1) the presence of digital technologies onsite as part of the visitor experience is generally minimal and (2) the use of digital technologies among visitors is generally not *expected by visitors*. *So how do these institutions go about addressing these challenges and creating an AR game? What did they learn from piloting games? What aspects of the games worked well and conversely, what problems arose and how were they addressed? How were institutions able to observe what impact, if any, AR gameplay had on visitors' experiences? What were the benefits or costs for players? How did institutions leverage their existing real-world affordances in their AR games?*

Each of the three participating institutions will provide an overview of their AR experiences:

Dollars and Sense at Old Sturbridge Village

Old Sturbridge Village is one of the country's oldest and largest living history museums, depicting early New England life from 1790-1840 with historians in costume, antique buildings, water-powered mills, and a working farm. Visitors can view antiques, meet heritage breed animals, and enjoy hands-on crafts.

This AR project seeks to extend our mission statement which emphasizes the personal exploration of history. Making connections between the past and the 21st century world is vital to keeping our audience engaged. Our goal in creating an AR experience with TaleBlazer was to provide a fun, interactive experience with history for visiting high school students. We are focusing on high school students studying US History because it addresses a curriculum framework requirement that fits well into the historical period we portray ((1)Mass, USI.27). Furthermore, students of this age can reason abstractly, and understand that decisions that are neither "good" nor "bad" can influence outcomes and lead to various results. This game is based upon that fact. We also have observed that our high school audience often seems preoccupied with their smartphones while touring the museum, so it is hoped this game takes advantage of that interest to educate them while playing a game. This pilot will evaluate how TaleBlazer may enhance visitors' experience of our unique environment and well-trained historical interpreters, and provide the students with an enjoyable and educational experience.

The game *Dollars and Sense* starts the player off as the Freeman Farm Family (the farm family was basic unit of 19th century New England life). As the player goes through the game the choices made will either lead their family to succeed or fail. Using both the in-game prompts as well as the museum's resources (costumed interpreters, signage, etc.) the player will make decisions to wade through 19th century life. Players will be introduced to 19th century modes transportation, market economy, division of labor, farm animals, trades men & women and a host of other characters.

Superhero Scientists at Drumlin Farm Wildlife Sanctuary

Mass Audubon's Drumlin Farm Wildlife Sanctuary is a flagship sanctuary, containing 232 acres of fields, forests, and ponds, and it is the only facility of its kind in Lincoln, Massachusetts. The property also features a sustainable working farm with crops and livestock, and a display of wildlife native to New England. Major programs include onsite environmental education and interpretation for general visitors and groups of all ages, an ACA-accredited day camp, a licensed nature- and farm-based preschool, outreach programs for schools and groups, and a community supported agriculture program and farm stand for the public. Drumlin Farm's educational mission reaches nearly 100,000 farm visitors and over 60,000 onsite and outreach program participants each year.

Superhero Scientists was developed to offer an engaging experience to young school age children grades 2-4 (with ability to extend to grades 1-5 with adult support) visiting the farm accompanied by adult caregivers. While families with preschool age children typically are content to walk the main "farmyard loop" trail to see the animals, those with older children (who are often repeat visitors) often ask, "What else can we do while we're here?" Providing an AR based game for visitors to download when they arrive is intended to spark their interest in exploring new parts of the sanctuary beyond the main loop (by guiding them to the "wilder" parts of the property over the course of the game). Equally importantly, it is an opportunity to engage them in a deeper virtual conversation about ecology, sustainability and conservation without requiring the presence of a staff educator.

Our target age group of grades 2-4 was selected to focus on the developmental level where basic scientific concepts of data collection, measurement, and maps and the ability to understand interrelationships within environmental systems (habitats, food webs, life cycles, etc.) are beginning to be established. Gearing the game towards family groups allows us to focus the game towards the reading ability of upper elementary age children, knowing that an adult will be present to help emerging readers decode the text and navigate the game interface.

Superpower Scientists puts the child in the role of scientists who are approached by different animals to complete a series of challenges. Each challenge takes the players on a journey around the sanctuary to make observations, assess different indicators, and respond to questions. For example, in the introductory challenge, a red fox who is visiting Drumlin Farm for the first time asks the scientists for help in finding a habitat. As players visit different hotspots on the sanctuary map, they are instructed to observe the environmental conditions around them and decide which habitat element (food, water, or shelter) the fox might find in that location. Points are awarded for each answer, with information provided to educate the players on both correct and incorrect choices. Completing the challenge brings the players to the site of Drumlin Farm's red fox display where they can observe live foxes up close and receive a "superpower" of virtual fox hearing (i.e., the ability to hear auditory clues in the game). This "superpower", which is a unique adaptation of foxes, can be used to assist them in subsequent challenges.

Our goals for the project include:

- Fostering awareness of the connections between people, land, and wildlife in a fun and engaging way (learning without noticing that you are learning)
- Bringing a new dimension to our existing exhibits by incorporating the information presented in interpretive signage in the game, as well as our natural resources (natural features and habitats, resident wildlife/livestock, and farming operations)
- Exploring innovative methods to leverage technology in environmental education in ways that literally augment the learning experience without distracting from or competing with the natural surroundings
- Increasing the number of people that visit the more remote parts of the sanctuary
- Promoting repeat visitation (as players want to return to play more challenges and earn more superpowers)

Missouri Botanical Garden

The Missouri Botanical Garden and MIT have collaborated since 2007 on several AR-related projects. Initial work in the partnership was funded by a pair of NSF grants focusing on teacher-led afterschool projects linking upper-elementary and middle school kids with their local community. Examples of projects supported included local watershed initiatives, response to tornado strikes, and access to healthy food in the community. For each, the AR was intended to be one component of a larger project. For example, the watershed AR game was a “kick-off” event that raised important environmental considerations that helped guide ongoing stream monitoring efforts. The tornado project linked to GIS mapping projects that let students use breaking data for a tornado that struck their community the week before. The Garden has also developed games for use in school programs, such as a “Who Rules the Forest” investigation which guides students to meet different woodland creatures, with a goal of determining which is the most important part of the food chain. Along with this educational work, MIT and the Missouri Botanical Garden collaborated on iterative development of the underlying AR software. TaleBlazer represents a third iteration, developed in response to the needs and challenges faced by program participants.

As an informal science institution, the Garden sees AR as an opportunity to advance its mission to promote personal commitment to the environment as well as interest and engagement with science. To guide program planning in this regard, they have adapted Shields (2011) characterization of four dimensions of character education, approaching each from a science perspective:

1. *Moral character* generally refers to how people interact with each other. Issues of kindness, consideration, and empathy are key here. What does it mean to be a good person, and to see the value in others?
2. *Civic character* moves past the individual to describe ways in which people show their commitment to their community: Are they committed to improving the quality of life for themselves and others? Are they seeking to improve the local environment?
3. *Performance characte*r describes how people approach tasks: Do they work hard and persevere in their efforts? Are they focused on doing their best, or just getting by?
4. *Intellectual character* describes ways in which people approach information and ideas: Do they keep an open mind and weigh evidence? Are they willing to reconsider previously held beliefs in light of new information?

Each of these dimensions of character is supported in the game designs themselves and in the supporting program offerings. For example, performance character is promoted both by providing a challenging game environment and by supporting student persistence as they develop, debug, and refine their game designs.

Looking ahead, Missouri Botanical Garden will be deploying games developed with TaleBlazer to engage a “free choice” audience of tweenagers and parents. Games will be designed to link families to the Garden’s extensive botanical research efforts in an engaging and kid-friendly manner. For example, imagine a family visiting the Garden on a Saturday morning. Typically a pre-teen kid will not find this an inherently motivating experience. However, by downloading an adventure app into a smartphone, the Garden grounds become a game space searching for an endangered species or perhaps plants used for food. By linking clues on the smartphone with direct observation of relevant plants, the value of the Garden's otherwise static and unengaging exhibits is magnified. In an effort to expand engagement, the Garden is also partnering with other local nature attractions such as CityGarden and Forest Park to provide complementary game spaces. Throughout, research focuses on sustaining engagement and motivation toward virtuous behavior: Does a game motivate real-world action?

Moderator Questions

Questions will be drawn from the following (along with those that emerge during the session):

- Each of you work in predominantly "low-tech" atmospheres. What challenges do you face when integrating technology-based AR games into a "natural" or "historical" immersive setting?
- Participants visiting your locations have rich experiences simply by "being there." In what ways do you try to leverage the AR game experience to enhance visitor experiences? Are there potential pitfalls that you see? How do you try to address these?
- How do you envision and measure a successful implementation of AR?
- What was the most challenging aspect of incorporating Augmented Reality into your institution?
- How does AR engage your audience differently from other offerings?
- How does having visitors who are interfacing with technology impact the experiences of other visitors?

Endnotes

(1) Massachusetts State Frameworks specifically addressed include USI.27 Explain the importance of the Transportation Revolution of the 19th century (the building of canals, roads, bridges, turnpikes, steamboats, and railroads), including the stimulus it provided to the growth of a market economy. (H, E)

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Well Played

Assassin's Creed III: The Complete Unofficial Guide, a Teacher's Limited Edition

Wade Berger, University of Wisconsin Madison, iuswade@gmail.com
Patrick Staley, V.O.I.S.E. Academy High School, ppstaley@gmail.com

Abstract: *Assassin's Creed III* (2012) was released with much fanfare, as it was the third major title in a series of successful open-world, sandbox titles. By design, *Assassin's Creed III* takes one step further at becoming a great piece of historical fiction which has intrigued game designers and history educators alike. The detail and accuracy in the painstakingly recreated 18th century cities and frontiers has received high praise and force the player to explore all that is around them—a staple of sandbox video games. Additionally, because the fictional storyline was written to closely follow the mystery surrounding real life events during the American Revolution, the game has become an excellent source for players to discover unknowns about these events, to uncover the variety of perspectives, and to investigate the causes and effects of political unrest present throughout the time.

100% Synchronization

A game in the sandbox genre is typically identified by its open atmosphere, variety of challenges, and its collections of hidden objects designed to force a player to explore the world to obtain "100% Synchronization" or to beat the game in its entirety. *Assassin's Creed III* (*ACIII*) is no different. Set in the age of the American Revolution, the game is built upon a sprawling landscape of colonial society, with everything a gamer could want from an open-world, action adventure game: naval combat, horseback chases, gunfights, a freedom to choose your own pace, a robust, narrative-based main mission line, and hundreds of bonus achievements, challenges and collectables.

ACIII does all of this, and it goes further to embrace a massive connection to factual representations of historically researched people, places and events throughout its plotline and extras. In his review of the *ACIII*, entitled "An alternate history, with footnotes", Martens (2012) describes in detail how the historical details included in the game outshine the actual game play. He suggests that because of the abundance of references and experiences tied to factual events, places, and people, the game "could be more fun to experience as a historical fact-checker than a player". It is exactly two of those types of players who present this well played reading of *ACIII*. Licensed as social studies educators, we sought out this game for the very purpose of diving deeply into its accuracies and inaccuracies with the goal of critically examining the game. We did so to gain a satisfaction at what content from the American Revolution it portrays accurately, and also to explore material where we could instruct youth to use the game to be critical of how history is told.

To be more precise of the position we took when we began playing this game, it must be understood that the difference between the historian and the history teacher is a difference in purpose. Both concern themselves with history and have a true passion and excitement for it. Historians, however, typically research and critique historic sources with an intent of building out a familiarity in regards to their area of expertise. Whether through writing, lectures, discussions and debates, their interactions are then shared and disseminated with peers who have both a similar interest in content as well as in the skills required to research successfully. On the other hand, history teachers, especially those in the elementary and secondary level in at-risk communities, must work with youth who might find their passion irrelevant and the skills required for uncovering historic truths unnecessary. The challenge for educators is to both study source material effectively and to resolve to replicate the research process with these youth in an innovative way. However, this is increasingly difficult for youth in an era of technology, video games, instant gratification and dissemination of information.

One solution is to approach the teaching of history in the same manner in which a large population of students is most engaged: through gaming. It is for this reason we were first drawn to *ACIII*. However, for this game to work with youth in a learning environment, it must first satisfy several criteria. McCall (2011) is an educator who has written about the effective use of historical simulation video games in the classroom, and he maintains historical simulation video games must have historical accuracies embedded deep in their core systems, and these core systems must provide "defensible models of historical systems" (McCall, 2011, p. 28)

While writing prior to the release of *ACIII*, McCall (2011) argued the *Assassin's Creed* series largely misses on these to points. However, through our attempts to reach 100% Synchronization as both players and historical critics, we have decided *ACIII* does in fact deeply integrate historical accuracies into the core gameplay further than the previous titles in the series ever even attempted. Furthermore, we argue by design, the plot points and characters depicted by the game with greatest historical inaccuracies do so in moments of history where little primary evidence can be provided to their exactitude. In several interviews since the release of *ACIII*, chief scriptwriter, Corey May has acknowledged the use of unknowns and mystery in the game's design, and further continued to state he hoped players would have "the ability to explore some of the more nuanced elements of the founding of the United States (Clark, 2012).

In these moments of nuance and where historical truth is unclear, Gerwin (2009) argues youth can be critical of these moments, and consider pieces of evidence available with intent to make their own judgments about what might have actually happened. It is this application of critical judgment of the game and the history itself which makes *ACIII* a viable source to investigate. It is within this framework, which we would like to provide a close reading of the game from the experience of someone who is explicitly playing the game with a critical lens towards using it for the purpose of their own personal learning. And in an effort towards our own 100% Synchronization inside of the game and out, we will include both the tools we used to play, and our thoughts on using it as a tool for teaching youth.

ACIII: History Employed for Evil?

In *Assassin's Creed III*, the player takes on the role of Desmond Miles and engages in his battle against the Templar Knights. In order to succeed in this fight, the player (through Desmond) uses a machine called the Animus to recreate memories of Desmond's ancestors. In this story, there are two ancestors of important value to Desmond, and thus worth experiencing—first as Haytham Kenway and secondly, as his son, Connor. Haytham is an English-born nobleman, a leader of the Colonial Templars, and a fictional character. Connor is introduced later in the game, and is also fictional; however, his role makes up a larger percentage of the game play, and represents the primary set of eyes through which the events of the American Revolution are presented. The use of Connor, who is part English and part Kanien'keha:ka (or Mohawk), offers the player an opportunity to view a perspective not often experienced or studied during the time of the American Revolution. This allows the player to be critical of events in the game and out, and also for the designers to introduce key plot elements which play on the player's position on the outside (1).

Prior to the introduction of Connor Kenway, the early stages of the game introduce mostly fictional game play, though there are several bursts of historical content to observe. However, it is after the player first arrives in the colonies, where the open exploration of history is introduced. Immediately after debarking the ship, which carried the Haytham across the Atlantic, the player is greeted by a somewhat wily and old Benjamin Franklin who encourages the player to run around Colonial Boston looking for lost pages to his almanac. The pages are scattered throughout the different stages, and can be collected at any time.

This is the first of many challenges where the player is asked to explore the world at their leisure, and in doing so, to find hidden objects of varying value. The most hardcore players will seek out and hope to find all of these items in order to further progress towards 100% Synchronization. Items hidden throughout the game include the almanac pages, synchronizations points, trinkets, treasure chests, feathers, and caves. While the task of locating these items offers little historical value to the critical player, the task of surveying their surroundings encourages the player to be constantly investigating everything they encounter in the vast environments of Boston and New York, as well as the frontier and naval stages.

The designers *ACIII* greatly reward those players who do take time to explore their surroundings in this way. The environment itself is perhaps one of the greatest assets the game possesses. Being able to show the expansive and incredibly detailed account of Colonial Boston, New York, and the wilderness beyond their borders is an opportunity not to be taken lightly. While an impressive environment was present in previous games, it is truly highlighted in *ACIII*. The attention to detail on the buildings, wildness throughout the wilderness, and navigation of ships across the Atlantic Ocean is incredible. The synchronization points hidden at the top of steeples and towers scattered throughout provide an opportunity to look out on panoramas and see, a near match to what the people living during that time experienced (Clark, 2012). Exceptional views the player cannot miss include the mass of ships docked in the port, smoke stacks rising above low level buildings, churches, businesses, and the sea of "Red Coats" and "Loyalists" below. For the historian, there is no greater thrill than being able to place yourself amidst the history you study. For players, these breathtaking viewpoints encourage further reason to explore and engage in the environment.

The environment presents a visually appealing and historically accurate setting for the game to take place. However, in order for the game to sincerely appease the historical critical player there must be a strong emphasis on historical content built within the missions. While the game's major characters and storyline are fictional it is closely intertwined with historical events, characters, and details.

ACIII: The Official, Official Guide

In order to complete the missions of the main storyline, and for our own quest for 100% Synchronization, we sought out the help of the accompanying guidebook, *Assassin's Creed: The Complete Official Guide, Collector's Edition*. Designed and published by Piggyback interactive Limited, the collector's edition guidebook fully complimented our game play. The animations used in its pages to guide a player through a particularly challenging mission are well designed and innovative (see Figure 1).

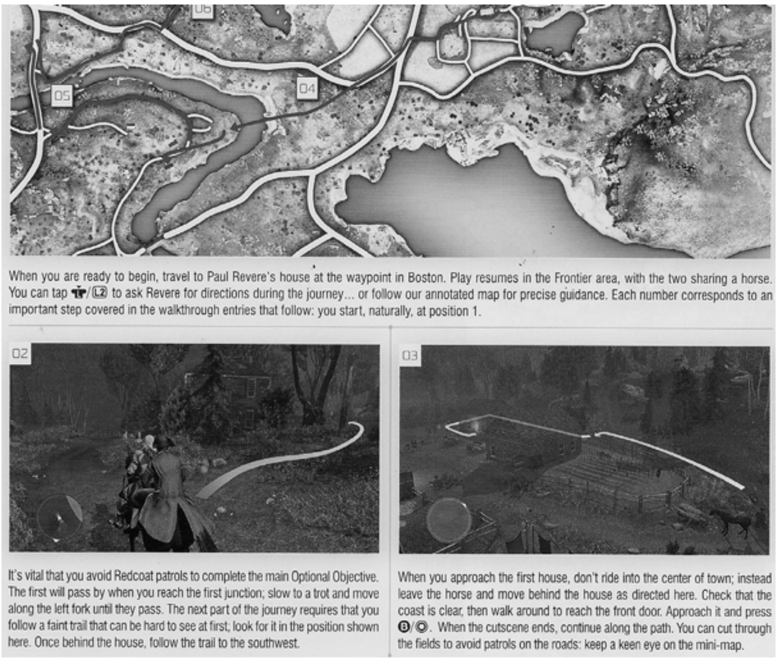

Figure 1: The use of arrows and recreated maps to guide a player to navigate Boston both in game and in history.

As an added bonus, the guide provides ample supplementary material surrounding both the design of *ACIII*, and its relevant historical plot points. There is an entire section entitled *history vs story* dedicated to uncovering the mysteries of the different plot points. Vetted by May, the lead scriptwriter, this section provides beautiful detail to the historical critic of this game. It is through material provided by May in this section that we were able to break down some of the most intense plot points and critical historical junctures of the game.

Charles Lee

Outside of *Assassin's Creed*, Charles Lee was a British soldier and general in the Continental Army, and these same details of his life are present in the game. *ACIII* then takes particular unknown aspects of his life and exaggerates them to fit the story. During gameplay as Connor Haytham, the player is constantly battling Lee over a variety of issues, including control of the land where Haytham's people reside. It is also revealed that Lee is actually a Templar Knight (one of a number of characters who represent this more fictitious plotline in the game). As a Templar, Lee is implicated, along with another character Thomas Hickey, in an assassination attempt of George Washington and other plots to undermine the efforts of the American Revolution. While this plotline might not reflect historical accuracy, May acknowledged how this fits inline with some unknowns about Lee and his inability to precede Washington as commander-in-chief (Beatty & Pargney, 2012, p. 333) (see Figure 2). By using Lee as an enemy to Washington, the game exploits an unknown about Lee—that he was a poor politician and political entity, and a more aggressive military leader than Washington—to further the plot of the game. This gives historical critics an exemplary opportunity to first examine the accuracy of the game, and then to be cautious of widely held notions about Lee and Washington.

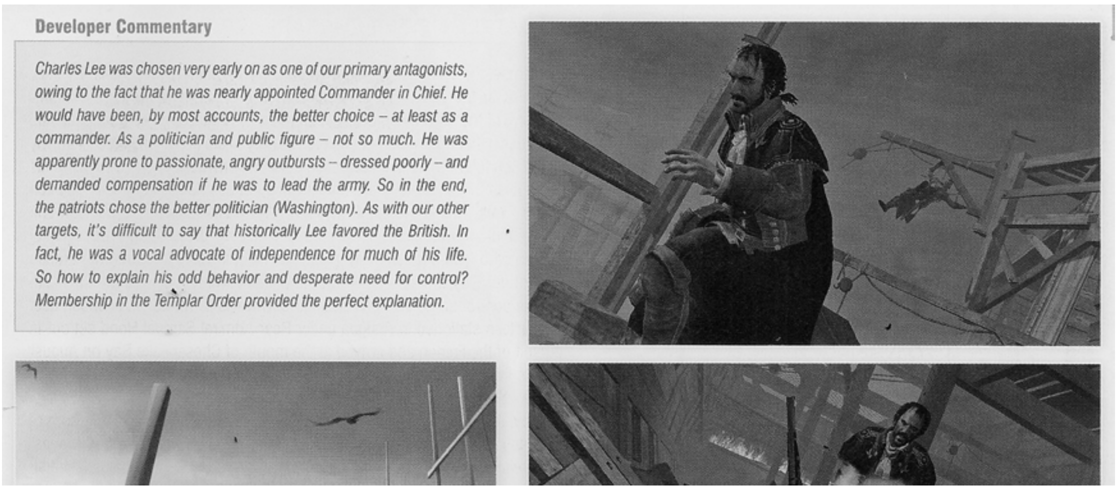

Figure 2: The Truth about Charles Lee as described by scriptwriter Corey May.

The Boston Massacre

Historical events, too, are exaggerated when necessary to intertwine with the story. The events leading up to and causing the Boston Massacre provide another unique opportunity to critique both the game and the traditional telling of the history of the event itself. Historians have widely debated who instigated the blood bath, but it is known that several civilians were killed and wounded at the hands of British regulars stationed in Boston on March 5, 1770. In *ACIII*, the massacre is triggered by Templars in order to frame Connor Haytham, though the reason for this framing is unclear to the player at the time of the incident (see Figure 3). This reflects the many unknowns surrounding the actual cause for the firing outburst, and by design, May stated in the collector's guide, the use of a fictional character like the Templar to instigate the carnage "puts an end to the discussion about 'who started it' (Beatty & Pargney, 2012, p. 322).

Figure 3: The start of Boston Massacre remains controversial in *ACIII*.

Assassin's Creed: Revelations

Assassin's Creed III, and our quest as educators to reach 100% synchronization uncovered many truths and mysteries surrounding the American Revolution. There are far more missions and characters than we can describe here which incorporate connections between fiction and non-fiction. It is the challenge for the player, and also the learning opportunity, for to focus on the analysis of these characters and events much like they would any other historical source to determine the bias and agenda behind the design of what is being studied. Players might focus on different controversial elements, and having to differentiate between historically accurate and fictional events in this way is higher order thinking that requires research and an analysis of primary and secondary documents with a focus on uncovering these biases and agendas.

Analysis on the scale provided by *ACIII* when a player attempts to reach 100% Synchronization simply does not take place amongst novice historians and researchers, especially when information is provided to the students through many other source documents and readings. Even if given the exhaustive list of primary and secondary sources used by the research team when designing this game, it would only be possible for the extreme experts of the era to uncover the details provided so plainly inside the game world to the player.

Endnotes

(1) The research efforts put into developing Connor's character are widely discussed online, and are discussed heavily in the interview with Clark (2012). Efforts to maintain cultural relevancy and accuracy included the full-time employment of a historian knowledgeable in Kanien'keha:ka culture as well as traditional Mohawk speakers for the voice over rolls.

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A Well-Played *Fiasco*: A Game About Powerful Collaboration and Poor Narrative Control

Sean C. Duncan, Learning Sciences Program, Indiana University, secdunc@indiana.edu

Abstract: The role-playing game *Fiasco* (Morningstar, 2009) provides an interesting case of collaborative narrative construction in the context of a game about a collective series of failures. Addressing the mechanics, dynamics, and aesthetics of the game (Hunicke, LeBlanc, and Zubek, 2004), this paper addresses the specific interactions of mechanics that give rise to the game's collaborative dynamics, and the sense of "fun" that evolves from the tension of narrative construction and character destruction. Implications for understanding collaboration and failure in learning are discussed, as well as instructional implications of the game's rule structures.

Introduction

"*Fiasco* is a game that is fun; it helps you to imagine. I hope you have fun while everything goes wrong." — Wil Wheaton (in Morningstar & Segedy, 2011)

In recent years, the field of games and learning has made significant inroads into understanding the connections between play activities and learning practices. However, it has perhaps inordinately focused on *digital* games — of the papers presented at the Games+Learning+Society conferences, the vast majority have involved computer, console, and mobile games, with only a fraction of the body of research being devoted to understanding the ways that games and play occur in other forms. In this paper, I attempt to broaden the focus of gaming experiences and forward an understanding of the meaning of narrative, collaborative games through a "well-played" analysis of a casual, tabletop role-playing game: *Fiasco,* created by game designer Jason Morningstar (Morningstar, 2009).

Fiasco provides us with a number of interesting and unique features that make it worth investigating in this context, and illustrates a number of potential mechanics that provide provocative instigations to the game-based learning community. In particular, I focus on the game as system in which a *collaborative narrative* is created by its players, as well as one in which *failure* is featured — not just as an acceptable outcome, but as the ideal one. As Wil Wheaton's quote from *The Fiasco Companion* (Morningstar & Segedy, 2011) indicates, the fun of "everything going wrong" is a central component of this game; I argue that *Fiasco* provides a distinct contrast to the forms of play that often dominate mastery-based forms of game-based learning, and even the implicit conception of productive failure (Kapur, 2008) that is central to many games. Note: Throughout this paper, I will reference examples from a satirical *Fiasco* Playset performed by members of the audience during this session — entitled "Games+Learning+-Impropriety" — and created specifically for GLS 9.0 (1).

Powerful Ambition and Poor Impulse Control

Fiasco was published by Bully Pulpit Games in 2009, an independent role-playing game company run by Morningstar and his frequent editor, Steve Segedy. The theme of the game is provocatively unusual for most tabletop role-playing games, which have historically been dominated by the fantasy, science fiction, and adventure genres. In *Fiasco,* players collaboratively create new characters for each game session based on the guidance of a minimalistic "Playset" consisting of 144 options for players to choose from. A "Playset" consists of a set of potentialities for a game session — while certain objects, and even character names may persist between sessions, each group of players and random rolls of dice yield very different stories. As a role-playing game, the emphasis is decidedly upon role-playing characters that are developed on the fly through the course of play of a common narrative.

For a tabletop role-playing game, the materials are quite minimalistic: The game does not require multiple types of polyhedral dice, miniatures, or graph paper. Consequently, there are no "player classes," no statistics to keep track of, nor additional "levels" to acquire. All that is required to play is a set of standard six-sided dice — four dice per player, two light and two dark — as well as blank index cards and pens. After creating characters (during "The Setup" stage), players act out a series of scenes, creating the story of the game with one another, dealing with complications to the story added halfway through (at "The Tilt"). The Setup involves the most use of the dice: players first roll them, then use the numbers rolled to choose elements from a Playset that will serve as the initial basis for their game.

Playsets are thematic and provide the settings, relationships, objects, and character needs that will drive the rest of the game. Those created by Morningstar and other officially-released Playsets vary quite widely in theme —

from “Tales of Suburbia,” set in a 20th century suburban housing development to “London 1593,” set in Elizabethan England. And, as the game is simple to adapt to multiple contexts, player-created Playsets abound, ranging from “All the Damn Time,” in which all players play the same character at different times in his life to an adaptation of the complex, city-building, roguelike computer game *Dwarf Fortress*. Perhaps in an attempt to make the salacious themes of many of the game’s original Playsets more palatable to a wider (and younger) audience, *The Fiasco Companion* includes additional Playsets such as the teen-centric “Fiasco High,” which aim for a lighter tone.

Each Playset is broken into several sections, reflecting key constraints that will guide players in the creation of their own unique game experiences. Rather than adopt pre-set characters during The Setup, players use the dice to pick specific Playset components, typically “Relationships,” “Needs,” “Locations,” and “Objects.” These provide seeds for the creation of characters and the story tensions that guide the game session. For example, since each Playset component refers to the connection between two players in the game, a player may choose a “Relationship” of “Family > Longtime industry rivals” to place between herself and the player on her right, while the next player may choose to flesh out that relationship with a “Need” of “Revenge… for the downfall of Jaymie Ludlow.” With just those two snippets — and the subsequent Relationships, Needs, Objects, and Locations chosen with other players at the table — players develop the barest outlines of characters, name them, and pick the settings and objects that will play a role in the evolving story.

It is important to note that with all Playsets, the goal of the game is to develop a disastrous situation or set of situations that unravels through the course of play —*Fiasco* is overtly a “game about powerful ambition and poor impulse control,” as *Fiasco’s* promotional tagline teases. Once The Setup choices have been pinned down, players strive to maximize their character’s goals (say, “wants revenge on his sister for her role in the accidental death of grad school crush Jaymie Ludlow”), while also acknowledging that a *failure* to achieve that goal may provide fodder for an even more enjoyable narrative experience for the group.

The game has been described as a “Coen Brothers RPG,” or a “story game” that attempts to mimic the uniquely shambolic noir-style narrative structure of many films by director/writers Ethan and Joel Coen, which include *Fargo*, *Blood Simple*, *Burn After Reading*, and *Barton Fink* and other similar exemplars in this film genre (such as *A Simple Plan*). *Fiasco*, while featuring much more freedom to shape the story than many traditional role-playing games, enforces this structure through several simple yet elegant game mechanics. First and foremost, there is no “game master” or “dungeon master”; characters collectively, collaboratively, and sometimes competitively develop the unique storyline that evolves from the choices made during The Setup.

After The Setup, dice are returned to the center of the play space for use in the rest of the game. As scenes playout in the first half of the game, players proceed clockwise around the table, choosing to (1) “Establish,” or describe a scene involving his or her character, naming other character(s) they wish to interact with; or (2) “Resolve,” letting the other players describe the scene he or she must play out. For scenes in which the player chose Establish, others who are not involved in the scene use the color of the remaining dice (light or dark) to indicate how *they* would like the scene to end. For example, if the grad student character Jerry Kapowski confronts Professor Mary Jacobs about her knowledge of Jaymie Ludlow’s murder with the hopes that she would acknowledge Jerry’s suspicions that she was involved, all of the players other than Jerry’s and Mary’s would determine the outcome for Jerry *during the scene*, choosing to give Jerry a light die if they believe he should succeed in finding out more about what Mary knows, or a dark die if they believe he should not. In scenes in which the player chooses to “resolve,” he or she determines the scene’s outcome and picks the appropriately colored die. In both cases, the scene progresses until its logical end, incorporating the die choice into the story on the fly.

The game progresses this way, allocating dice each turn with the player receiving the die and giving it away in the first half of the game, and keeping it in the second half of the game. Accumulated dice are rolled again twice — first, halfway through the game, at which point the difference between light and dark totals drive complications (“The Tilt”) that affect the game, such as “Tragedy: Death, out of the blue” or “Guilt: Someone panics.” At the end of the game, accumulated dice are rolled once more and differences calculated again, for each player to develop a montage that describes what happens at the end of the story (“The Aftermath”). At this point, the game is over — there are no point totals, the characters do not proceed into another game scenario (c.f., the recent “American Disasters” Playsets; Morningstar, 2013), and the story has wrapped up.

Since its release, *Fiasco* has spurred a newfound interest in role-playing games without game masters, and has shot up the ranks at the online role-playing game community site RPGGeek, where it is currently listed as the second-most highly rated role-playing game on the site (RPGGeek, 2013). Morningstar has developed other narrative-based role-playing games, before and after *Fiasco*, including *The Grey Ranks, The Shab Al-Hiri Roach,* and the recent *Durance*, accruing acclaim for his innovative approaches to the role-playing game form.

The Mechanics, Dynamics, and Aesthetics of a Fiasco

One approach to developing an account of the “well-played” nature of *Fiasco* first involves isolating its components, then addressing the ways that the game’s components lead to particular experiences by its players. I adapt Hunicke, LeBlanc, and Zubek’s (2004) “mechanics, dynamics, and aesthetics” or MDA approach to this end, as a means of illustrating how the game’s simple mechanics give rise to its complex and interesting collaborative narrative play. By focusing on elements of the game’s explicit and implicit rule systems (mechanics), one can see how the game develops second-order strategies and approaches (dynamics) that build a sense of “fun” (aesthetics) for its players.

Mechanics

First off, it is surprising that such a compelling game experience can arise out of so few overt game mechanics. The most relevant of these mechanics for this argument are the game structures that embody constraints imposed upon players by the game’s rule system.

- *Dice Choices* — Used in The Setup, the random dice roll at the beginning of the game provides players the opportunity to choose elements of their characters’ stories (within constraints); players throughout the game choose light or dark dice to pass along to the player whose scene it is

- *Establishing/Resolving* — Players choose whether or not they will create the setting for a scene, and whether they or other players will determine its outcome (a light or a dark die)

- *Dice Transfers* — During a scene, players give a participant in a scene a light or dark die to shape the direction the story should go; at the end of scenes in the first half of the game, the receiving player passes the die along to another player

- *Dice Calculations* — At both The Tilt and The Aftermath, each player rolls accumulated dice, and calculates a difference between light and dark that affects the course of the rest of the game (in The Tilt) or the particular fate of their character (in The Aftermath).

- *Turns* — All play proceeds clockwise, with each player taking two turns establishing or resolving before The Tilt, and then two turns afterwards, before The Aftermath.

These minimal mechanics all drive *narrative* choices — elements of The Setup, who chooses the outcome of scenes, who accumulates which color dice, and how these accumulations of dice impact the story. All other elements of the game’s narrative are left to the players’ imaginations, be it finding out who is actually responsible for Jaymie Ludlow’s murder, whether or not Jerry will be successful in stealing the $69,105 of conference registration money, or perhaps finding out if Dr. Mary will finally bed the alluring game designer she has her eye on. The game’s basic mechanics thus serve as *constraints* for the story’s development, but are not deterministic of any particular narrative.

Dynamics

One might wonder, then, how does a “fiasco” evolve from these game mechanics? In what specific ways do these game mechanics interact to support and shape the particular form of collectively disastrous narrative that the game is intended to model? Through the *interaction* of multiple base mechanics, we can see the development of second-order dynamics that illustrate the shaping of these narrative arcs.

One of the most critical interactions is between the mechanics of *Turns* and *Dice Transfers*. The most elegant enforcement of the narrative arc is through the simple reality of the limited supply of dice in the game — there are four per player, two light and two dark, yielding 12 total dice in a 3-player game, 16 in a 4-player game, and so on. *Fiasco*’s common pool of dice for all players is used up through the course of deciding small-scale narrative choices (*Dice Transfers*), and it should be no surprise that as the number of dice in the central pool depletes, so does the flexibility of players to change the outcome of a subsequent scene. That is, if characters tend to get their way early in the game (players receiving light-colored dice), then the pool of remaining dice will be skewed dark for the latter half of the game, and vice versa. This often yields either a storyline in which “everything goes wrong” at the end, or “everything goes wrong” early on, with characters successfully dealing with the repercussions for the rest of the game.

Games of *Fiasco* necessarily take a “bad turn” because the dice allocation throughout the game provides players with an equal number of opportunities for their characters to get what they want, and for their characters to be thwarted in the attempt. Compounding this, a disproportionate allocation of dice (*Die Transfers* interacting with *Establishing/Resolving*) leads to the chance that not all players end up with an equal number of dice, and thus a greater subsequent chance that consequential *Die Calculations* will be under their influence (at The Tilt, in particular).

Therefore, a dynamic emerges that (in at least the best-played *Fiasco* sessions), conveys a sense of entertaining, collective doom to the players. There is no such thing as a "winner" in *Fiasco*, and the movement of dice in the game reinforces this for all players to see. The *collaborative* structure of the game begins to emerge through the crafting of an ideally coherent and fun narrative in which players' choices are simultaneously fodder for the development of the story and also signifiers of an inevitable, often hilarious catastrophe for the characters.

Aesthetics

Finally, we turn to "fun." The aesthetic of "fun through failure" pervades *Fiasco*, supported by these game mechanics and the collaborative narrative dynamics laid out above. But, why is failure "fun"? Aren't we, as gamers, supposed to view "failure" as a state to be overcome in our progressions toward increased skill and mastery within a game-based context (Ramirez, 2012)? Or, aren't we as education researchers, supposed to view "failure" as a useful tool that leads to the accrual of new knowledge, skills, or practices?

An element heretofore not discussed in this paper, but which is clearly central to the "fun" of *Fiasco* is *role-play*, studied extensively in games from its earliest days (e.g., Fine, 1983) through digital forms (e.g., Simkins & Steinkuehler, 2008). Through the process of role-playing characters within a game of *Fiasco*, players are faced with a critical tension between individual and collective narrative development. On each turn, players act within a scene with one or perhaps two other players at a time, and at these moments, are responsible for following through with their characters' goals while also acknowledging the constraints of the dice. The social, contextual, and ultimately *collaborative* nature of role-playing fosters a joint creative enterprise, one in which not only are characters created anew each time the players roll the dice on a new Setup, but an entire world is crafted through their joint activity. To satisfy the entire group, sacrifices must be made.

And so, perhaps, the "fun" of *Fiasco* evolves from the joy one can have in the push-and-pull of both collaborative narrative construction and individual character destruction, from balancing the individual goals of shaping a character with a story that can't end well for someone. A good game of *Fiasco* works as a temporary and fluid narrative space, one created for a just few hours to play around in and then part with willingly. There are ultimately no long-term consequences for the players, and the joys of causing fictional strife within the game space seem akin to what Gee discusses as a game-based "psychosocial moratorium" (Gee, 2003). I argue that a "well-played" game of *Fiasco* is, in some ways, like an improvisational, collaborative (and obviously much more transgressive) version of *The Sims* — one in which the simulation of a world and its people is recognized as a space in which one can tinker, improvise, imprint their knowledge of media (e.g., the tropes of Coen Brothers-style films) — then tear it all down for the sake of creating an entertaining group experience.

Collaborative Narrative and Failure In Learning

Ultimately, Games+Learning+Society is a community that is interested in games not just for games' sake, but for what these media can reveal about learning and action in the world. And so, it seems reasonable to consider what a "well-played" analysis of a game like *Fiasco* can help to inform us about learning, education, and games for impact. On the face of it, the noir-like themes of *Fiasco* seem a relatively poor fit to many of our contemporary, formal, and politically conservative educational contexts, but this assessment may be at least partially incorrect. In "Better than Ritalin!: Playing With Students," a chapter in *The Fiasco Companion* (Morningstar & Segedy, 2011), Morningstar and two teachers — MJ Harnish and Pete Figtree — took part in an extended conversation on the ways that the game has been used in classrooms, including the fostering of collaboration, listening skills, and creative writing.

And so, conclusions about *instruction* can be gleaned from Morningstar's efforts to shift the role-playing game genre away from only those systems in which a single player (the game master) holds the keys to the group's story. In an educational system that still over-emphasizes "sage on the stage" forms of direct instruction, *Fiasco* embodies a provocative model in which participants are guided by a common rule-based framework, but have the room to explore a wide range of settings, characters, and narrative possibilities. If Morningstar, Harnish, and Figtree's examples have broader application to game-based learning environments, it may be in provoking the application of these empowering structures to a wider range of creative exercises. *Fiasco's* players are equal participants in the development of any particular game session's characters and world; through their actions, players bring a heightened degree of agency to the game experience not found in many other role-playing game systems (tabletop or digital).

Finally, in terms of learning more broadly construed, *Fiasco* also presents a fascinating example of the ways that a minimal set of game mechanics can foster rich, collaborative dynamics, while providing productive a liberating sense of "fun" through failure. In most educational contexts, failure is clearly still seen as stigma. Progressive perspectives in the learning sciences (e.g., Kapur, 2008) have recently considered the potential of re-imagining failure as productive, but even in these cases, failure is still seen as a scaffold to foster some form of skill mastery, knowledge construction, or to serve as an impetus for future learning. I forward that *Fiasco* provides us a more subversive and provocative example of "productive failure," where it serves not just as an impetus, but as a *liberating experience* — one that, simulated in the context of games, can give players a space to imagine characters and build worlds, all the while joyfully taking them apart.

Endnotes

(1) The full "Games+Learning+Impropriety" Playset is available for download as a PDF at http://se4n.org/games/GLS-Fiasco-Playset.pdf. This Playset is licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 3.0 Unported License.

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Ninja Gaiden Black and the Tutorial-Less Tutorial

Jason Mathias, University of Southern California
Jason.Mathias@gmail.com

Abstract: *Ninja Gaiden Black* (Xbox, 2005) is a game of legendary difficulty amongst hardcore gamers, a game so hard that the first level lacks even the instructions on how to move. Yet this design style leads to a strong sense of player agency – in a space with no enemies, the player can simply *learn by experimentation*, using the few buttons on the controller. The first enemy encounter is also a teaching moment – Early enemies are agile ninjas just like the player character, and their actions mimic the attacks and movements of the player, so that she can learn by watching the enemies she is fighting. This talk is an exploration of *Ninja Gaiden Black's* approach to the tutorial-less tutorial, and how educational games could incorporate this style.

The Teaching Challenge

Ninja Gaiden Black's main character is a quick, agile ninja, not an ox-like warrior. In order to survive, the player must spend a large amount of time dodging and weaving, finding just the right time to strike. All of this requires a deep understanding of controls - not only of single buttons and what they do, but button combinations and when to use them. Modern games – both educational and commercial – use long tutorials that slowly walk players through movement and combat, using practice dummies or contrived scenarios, which tell the player how to move, but often lack a sense of experimentation from those early levels.

Instead of painstakingly instructing the player on how to navigate and conquer the virtual battlefield, Team Ninja, the game's developers, opted for a different teaching style – To make the beginning of the game an open sandbox, and make experimentation the basis of navigating levels and conquering enemies.

The Mini-Sandbox

The very first level of the game, the player stands in a riverbed. There are no enemies attacking the player, but also no instructions for where to go, or how to get there. So, the player simply has to press buttons and figure out how to move, how to jump, and how to get out of the riverbed. For a game that will later be very intense and require quick reflexes to survive, this beginning scene is surprisingly calm.

Figure 1: The Riverbed the player must escape from. No enemies! No chance of failure! …But no instructions, either.

Ninja Gaiden Black is played on the Xbox or Xbox 360, so any input in the game is done via a gamepad. The gamepad has 11 buttons, a directional pad, and two analogue sticks, and pressing all of them in order to discover what happens on screen takes a small amount of time. Since the player knows all the buttons that could possibly affect the game space, she will most likely press them until she figures out how to proceed. In doing so, she will likely discover actions such as quick slashes, heavier attacks, and eventually, how to move around the space. Thus, these essential actions are 'figured out,' rather than taught through traditional instruction. This is more engaging for the player as well, as there is a sense of discovery to these actions.

The space is then structured to require combinations of button presses to navigate – The player must get out of a riverbed, but in some areas, she must hop over a gap, while in others she must run along walls to cross larger gaps. These more complex movements often come with a text description of what the player must do, but still lack the 'press A to jump' button-style explanation of tutorials. In other words, the game will tell the player that she can run along walls, but won't tell her what buttons to press.

Tutorials as Hints (and Sometimes as Backup)

While tutorials are minimal, they do appear when the game wishes to teach the player how to interact with certain types of geometry. For instance, the player character Ryu can run on water with the right button presses, and the player would not know to try that feat, so when the player first encounters the flowing river, a tutorial message explains how the ninja can run on water.

It's important to note, however, that when a prompt pops up, the player is often told *what* she can do, but not *how* to do it – The prompt merely serves as a way to guide the player's mind on how to proceed and beat an obstacle, without giving the player the solution.

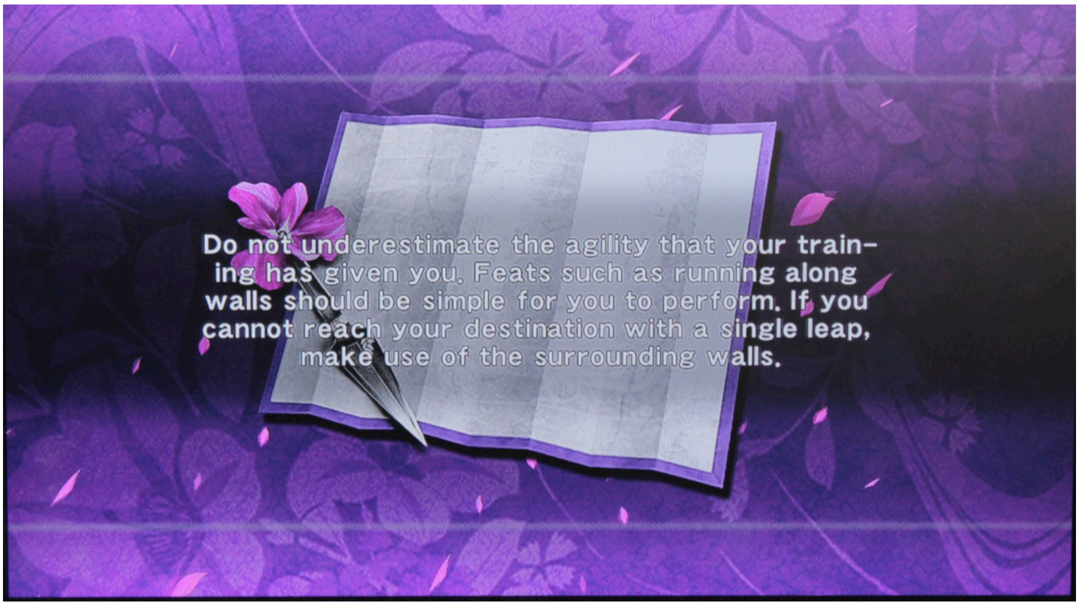

Figure 2: Complex, terrain-specific instructions are explained as hints to the player – Note that the prompt does not explain *how* to run along the wall, only that it can be done.

It is worth noting that a few prompts do explicitly state buttons that should be pressed, particularly when it serves a combat function. For instance, the rolling dodge is a move that requires the player to understand not only how to block (pressing the left trigger) but also that when blocking, using the left analogue stick to move does not make the player character run, but rather roll, avoiding sword strikes. Right before one of the early combat scenarios, the player is told of this complex move via a text prompt. This move is complex, and it would be difficult to explain this without explicitly stating the buttons required, so the game makes sure to explain the buttons within the prompt. Since the player character's life may depend on understanding the move, more tutorial-styled explanations are given.

Elegant Controls Facilitate Experimentation

It is worth noting that experimentation would be much harder if this game was on a keyboard or touch interface – With more than 50 buttons to press or a more ambiguous blank space, the player wouldn't really know how to go about pressing buttons. With only 14 or so options, however, the player can mentally map successful feedback to specific buttons and remember them much more easily.

(It is important to note that, while not every educational game can be on a gamepad, what is important here is not the gamepad itself, but the fact that the player mentally sees only a few options for interaction. A touch screen broken up into a series of buttons or visually squared off areas could very well have the same effect.)

Much of the game's success can also be attributed to the smart controls. The game starts with industry-standard controls (movement via the left joystick, attacking and jumping via the face buttons), so the player doesn't have to un-learn the controls that they're used to. The game-specific controls, however, are designed so that the player doing one action can stumble upon another.

For instance, when I first played *Ninja Gaiden Black,* I figured out how to roll accidentally when pressing button combinations, and realizing that using the left trigger when moving would result in a speedy roll. However, since no enemies were attacking me in the beginning riverbed level, I did not realize that holding the left trigger actually *did* anything more than enable rolling. However, when encountering my first set of enemies, I rolled, and the enemy slashed at where I was going to land. Yet, instead of getting hurt, my player character blocked – I had held down the trigger, intending to roll a second time, and that trigger caused a block. Because the designers thought to make 'defensive' movements (blocking and dodging) using the same modifier (the left trigger button), I could accidentally discover how to block, without being told.

Improvisation in Combat

Halfway through getting out of the riverbed, a few ninjas attack. The player can try out the attacks she has learned, and see that they have a solid effect. Thus, the traditional pattern of a beat-em-up is established, without actually instructing the player. But a curious thing happens – The enemy ninjas are aggressive. So aggressive, that they attack where they know the player is going to land when she rolls or jumps. The player now has to use jumping and rolling as an evasion tactic, or aggressively attack using moves discovered only minutes before. (If the player did not accidentally hit an 'attack' button during experimentation, they will likely flail about on the gamepad looking to discover the button at this point. Since the attacks are tied to the front buttons on the gamepad, they will likely be easy to discover, and the player will learn that way, instead.) This rapid processing of skills is a direct result of pressure by the game system, providing a negative feedback when the player is not at a high enough skill level. While there is a certain amount of skill necessary to get to this stage, once the player is at this stage, she can learn rapidly using this pressure-based experimentation.

Figure 3: Combat with Ninjas that mimic the player make the player very aware of her own strengths and weaknesses, lessons that can then be used to fight all sorts of enemies. Image source: http://videog-ames.techfresh.net/ninja-gaiden-dragon-sword-trailer/

Finally, the enemy ninjas themselves use the exact same moves that the player performs. They can jump, dodge, and slash using the same moves that the player does, albeit a bit more basic Thus, if the player does not already know how to, say, jump off of a wall in order to dodge a blow, she will see the enemy do it, and realize that they could do that as well. (Similarly, she will know when dodging isn't a good idea, because she will catch a ninja leav-ing itself open to attack, and use it to kill her enemy. That's a lesson that's hard to forget!)

This leads to a sort of discovery by observation and mimicry, a way that the designers can secretly tell the player the best moves for getting out of any of the game's most dangerous scenarios. Once this first level is done, the player will be well equipped with a basic language of how to move, jump, dodge and strike, and will have built a solid game plan how to face the enemy in what could have been a frustratingly difficult game world. Later on, the enemies become monsters with more devastating fighting styles and attacks – yet the foundation that the player has gotten from surviving the first level with little instruction prepares them to face their enemies head on.

Takeaways for Educational Games

Ninja Gaiden Black does not seem like a great example of an educational game, but it is an excellent lesson in giving the player the ability to learn on her own terms. Many times, there is an attention barrier for more practiced players playing a game (educational or otherwise) - A game's first few levels often lack engagement due to rote item-by-item tutorials, which interrupt the flow of the game. *Ninja Gaiden* gives the player an open level and enough feedback for the player to learn to navigate it.

The solution, however, isn't simply refusing to tell the player how to play the game, as that would simply invite frustration! *Ninja Gaiden Black*'s success is because of a design that limits the possibility of input, minimizes failure, and has a relatively high standard for success. In other words, the player needs to have an intuitive control scheme to experiment with, and feel free to experiment without the frustration of dying or being hindered because of not doing a specific combination. Yet, the experiments should *mean something* – once they've had that time to experiment, they should be tested on their discoveries, so that they understand what the reason is for learning this newfound skill, and cement it in their memories as ways to beat challenges.

As was mentioned previously, it is worth noting that button-press experimentation works best when there are a small set of buttons to press. If the game was on a touch screen, for instance, experimenting with movement would be much harder, as the player wouldn't be sure if they should tap screen space, or swipe with one or two or three fingers, or hold a finger on a point – The possibilities seem endless in comparison to 13 or so buttons and a few joysticks. However, that doesn't mean that a tablet game can't allow for experimentation. Buttons on the screen, or spaces that the player can visually sense are for pressing or swiping – those kinds of indicators give the player a sense of 'known possibility space,' letting the player not guess at how to create input, and get to the task of figuring out what inputs to actually make.

During this period of experimentation, it is important to provide strong feedback and rewards, and minimize negative punishments. The time for tests will come later – experiment spaces need to feel as free as possible. Once the player feels she is ready to continue, she will, but until then, she should be rewarded visually and mechanically with feedback that tells her how her inputs translate into actions.

According to the 'Just In Time' and 'Transfer' principles put forth by James Paul Gee in *What Video Games Have to Teach Us About Learning and Literacy* (2003), tests should come soon after one has learned a particular action or mechanic. It isn't necessary for tests to be difficult early on, but they should require a challenging level of engagement soon after the period of experimentation, so that the experiments feel like they were learned at a time when they were useful. If the player learns something by experimenting, yet doesn't have to use it for a while in a scenario that matters, she will likely forget it and move on to the other challenges that are present in the game. If the discovery is immediately transferrable, however, the player will transfer that knowledge to attacking new problems, and the period of experimentation will have yielded a lesson.

Conclusion

Ninja Gaiden Black is not hampered by its lack of tutorial, but strengthened by it. For such a 'hardcore,' punishing game, players learn to adapt to and conquer their surroundings and opponents fairly quickly through rapid digestion of information, largely because they are provided the means to *act* in order to discover their moves. *Ninja Gaiden Black* is not unique to this type of teaching-by-experimentation, nor is it the only style by which a designer can teach by experimentation. However, it is a stellar example of such a philosophy, and its lessons could be well applied to future games, educational or otherwise.

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Worked Examples

Collaboration in Context: A Working Example for Connecting University Stakeholders in Digital Media & Learning

D. Matthew Boyer, Danielle C. Herro, Shaundra B. Daily, & Juan E. Gilbert, Clemson University
dmboyer@clemson.edu, dherro@clemson.edu, sdaily@clemson.edu, juan@clemson.edu

Abstract: Research and teaching concerning Digital Media & Learning (DML) should not be the sole responsibility of one university department or program. Developing effective programs must be a partnership between various stakeholders seeking to design coursework, spaces for interaction, and collaborative projects. Recognizing that the undertaking must acknowledge individual situations and contexts, we explore the viability of our collaborative, interdisciplinary venture to build a comprehensive DML program at a traditional university. Research, models of DML across the country, previous experience integrating digital media for learning, and consciously navigating the reality of culture, policies, and challenges in education informs our work. In this working example we detail the existing structures, institutional offerings, nurtured relationships, challenges and early successes from our endeavor. We invite critique and scholarly conversation towards considering similar models across institutions, disciplines, and settings.

Initializing and Investigating

Creating interconnected opportunities for coursework and research in a university setting can be a daunting challenge. Institutional barriers, unintentionally placed, yet deemed administratively necessary, often run counter to modern narratives of cooperation and interdisciplinary studies. Resources, infrastructure, mandates and requirements complicate transformational efforts in schools (Collins & Halverson, 2009; Klopfer, Osterwiel, Groff, & Haas, 2009). Supporting various university stakeholders to bring their interests, voices, and strengths to a collaborative endeavor is a complex problem that may be best solved via understanding best practices and being mindful of individual contexts. The first section of this paper looks at the ideas and inspirations behind creating a comprehensive digital media and learning (DML) program in a School of Education (SoE), consequently leading to understanding the influence of past practice and existing culture. We continue by discussing the "participatory culture" (Jenkins, Clinton, Purushotma, Robison, & Weigel, 2006) purposefully being cultivated to support the design and development of collaborative DML research, projects, and spaces. We conclude with a discussion of our initial challenges and successes, inviting scholarly critique.

The Context

Our work begins at a large four-year, public university with high research activity. The institution has the elected classifications of curriculum engagement and outreach and partnerships (Carnegie Foundation for the Advancement of Teaching, 2013). Undergraduate studies include professional programs in addition to the arts and sciences, and many graduate programs at the doctoral level have a strong STEM basis. Currently, the university is engaged in restructuring the SoE to become a stand-alone entity within the university focusing on regional and national issues of policy and practice related to P-20 Education.

Within the SoE, the Educational Foundations department is leading transformation efforts in the approach to how modern technologies are used with teaching and learning. New faculty hires in the area of DML have led to updating curriculum, a renewed commitment to faculty learning, and a concerted effort to create research and teaching partnerships across the university. Initially, this work has resulted into collaborative research between the SoE and School of Computing (SoC), as well as connections with Architecture, Business, and Communications. To that end, this panel joins two DML faculty in the SoE and a SoC Distinguished Professor and Chair of Human Centered Computing using the working example model (Barab, Dodge & Gee, 2009; Gee, 2010) to detail the idea, inspiration, question(s), and determination of "knowing success" (Working Examples, 2013), while building a comprehensive DML program.

The Idea

The overarching idea is to build and support continuing relationships between faculty, students, and related stakeholders around issues of teaching and learning with digital media. Whether the initiatives translate to stimulating student use of digital technologies in pre-professional coursework in Teacher Education, or as a way to examine users interactions with robotics in Human Centered Computing is not a primary concern; the broad goal is to create an environment for successful collaboration that includes physical spaces, virtual communities, trans-disciplinary coursework, and interconnected research while reaching out to a range of stakeholders interested in DML.

The Inspiration

The impetus for this work began with hiring new faculty in the SoE who started their work with two significant challenges: to build a research and teaching laboratory focused on Digital Media & Learning, and to engender a cultural shift evidenced in changes to curriculum, pedagogy, and perspectives. While the former seemed to be a question of physical space and programmatic decisions, promoting a participatory culture among faculty, students, and administrators soon became the overriding theme related to both challenges. Unsurprisingly, implied and imposed paradigm shifts in research and teaching with DML have caused tension, both positive and anxiety provoking, for many stakeholders and educators. While university administrators agree Internet technologies are shifting practices in higher education, they are generally unsure of the scope and magnitude of change (Anderson, Boyles & Rainie, 2007), which further complicates efforts for DML initiatives. To that end, accepting change as an unstable and uncertain - yet motivating and challenging way forward shaped by participation, guides our work (Thomas & Seely-Brown, 2011).

The work is further inspired by similar university programs and emerging P-12 initiatives from innovative educators seeking to remain relevant while meeting the needs of their changing student populations. University sponsored programs, centers, and research-to-practice focused organizations such as Arizona State University's Center for Impact, MIT's Media Lab, The Institute of Play, and University of Wisconsin Madison's Center for Games+Learning+Society, and Stanford's d.School offered ideas, models and research to draw upon. Additionally, we looked towards innovative teachers in P-12 successfully using digital media and gaming platforms in school, such as Google Apps for Education (http://www.google.com/enterprise/apps/education/) mobile devices, augmented reality games, World of Warcraft (Blizzard Entertainiment, 2001), Minecraft (Mojang, 2009), Kodu (Microsoft FUSE Labs, 2009), and GameStar Mechanic (e-line Media, 2010).

While models, experiences, and instances of integrated DML are emerging, the limited presence of spaces promoting DML in Schools of Education and libraries highlights the lack of university preparation to meet current needs and provide the type of leadership and foresight necessary to promote research and teaching in higher education.

The Questions

The general question is, "How can universities create a participatory culture that values interdisciplinary approaches and supports investigations related to DML, and joins educational institutions while connecting informal and formal learning**?"** Of course, this brings to mind the sort of wicked problem (Buchanan, 1992) that too often results in fragmented attempts and competing goals, leading to unintended outcomes as lethal mutations (Brown & Campione, 1996). To guard against these results, focusing on *process* becomes as important as steering toward product. The specific question then becomes how to support an ideal of collaboration *in context* ensuring that a range of stakeholders has avenues for success within collective work.

Knowing Success

Fashioning a template for participatory culture, subjecting individuals to predefined roles, and publicizing idyllic perspectives will not result lasting, organic, or progressive success. In fact, prescribing specific models runs counter to a "participatory culture" (Jenkins et al., 2006). Our focus is long-term, using a design-based approach where iterations of reflection, revision, and implementation require stakeholders to examine themselves, their roles in collaborative work, and the system as an interconnected whole. Success will not come in the form of one metric, but will be seen in the portrait created by related examples of cooperation in research, teaching, and outreach across and beyond the university.

Contemplating the portrait is an ongoing process. Our challenge is to examine each component for value as an independent project while contextualizing and considering its overall place. In addition, generating a shared vision for a participatory culture in which stakeholders see the value in collaboration and know how to work toward this perspective of success is an important and ongoing goal. In the next section, we highlight the steps we have taken, and plan to take, toward realizing this shared vision.

Designing and Developing

As previously mentioned, we developed our working example from a variety of existing models: projects from P-20 schooling and informal educational settings (ChicagoQuest Schools, 2013; DMLcentral, 2013; Quest to Learn, 2013), reports from university and foundation researchers (Arizona Board of Regents, 2013; Institute of Play, 2013; The John D. and Catherine T. MacArthur Foundation, 2013), and existing models of environments where a participatory culture has supported work with digital media in teaching and learning (Digital Youth Network, 2013; DML Research Hub, 2013). To enhance collaboration in our local context, we have looked outside our university for ideas, perspectives, and products that have helped other organizations to sustain productive efforts in curricular revision, pedagogical transformation, research adaptation, and policy reform.

Preparation

Upon being hired as Assistant Professors of Digital Media & Learning, we focused on understanding structural considerations of the university as well as logistical constraints for the planned work. As part of this investigation, we have gathered a group of interested parties including new and existing faculty in the SoE and SoC. Administrators from both schools are additional stakeholders, as are individuals from university-level executive and academic administration. Other partners include professors and students from programs in Architecture, Business, and Communications. This has created a multi-leveled, multi-faceted network of communication and participation. For example, early work to create and offer cross-listed doctoral courses pairing SoC and SoE majors serves to (1) provide a foundation in computing, design, and the learning sciences; (2) build collaboration, peer apprenticing, and collective intelligence; and (3) offer students and faculty avenues of learning and scholarship that may have not been previously or easily explored.

Our connected framework is developing. Our goal is to solicit input, build collective understanding, and forge opportunities for participation. Sharing objectives originating with our core group, we have begun an ongoing conversation about communal goals for ourselves and for our external partners in schools, corporations, and government.

Specific Goals

The primary goal for our core group is to promote a participatory culture that draws interested stakeholders into developing work with DML. At different times and places, this takes on different meaning, but strengthens connections supporting work in diverse topics associated with teaching, learning, and researching with digital technologies. Currently, this primary goal has prompted two specific undertakings: the creation of a campus lab for research and teaching with DML and the promotion of collaborative research project that spans disciplinary divisions. Although the Digital Media & Learning Lab will be physically located in the main School of Education building, our plan is for it to be open and accessible to individuals and groups across campus as a tool-infused space for digital media projects.

These two actions lead into our long-term goal of a cultural shift in that they model the types of activities that colleagues can use in their own teaching and research. Workshops, coursework, organizational gatherings, and research projects function under the ethos of collaboration, communication, construction, and critical thinking vital to work with digital technologies. For instance, interdisciplinary researchers and university students organize media creation or design experiences in P-12 schools and then invite involved teachers to co-teach workshops to peers, university students and faculty. In this way, educators in the broadest sense learn from one another, while considering one another's realities and contexts. Akin to the conceptual and operational themes of DML, process and product have a reciprocal influence encouraging a participatory culture.

Methods

If *leave no stone unturned* can be called a method, then, in spirit, that is our beginning. In fact, we have relied heavily on the combination of individual stakeholder experience and collective expertise from our colleagues in similar situations at other universities. While our core group is not designed to be static and exclusionary, we have a strong cohort of participants, including faculty, students, and schoolteachers, who are all part of the initial venture. We rely on the breadth of experiences each bring to this process, and look to the reported results of others in their related attempts toward cultural shifts in an academic setting. We continue to investigate similar projects in a range of settings, and transfer what is contextually applicable to our situation. We have brought a collective appreciation for design-based methods into our planning, so that design thinking informs the iterations of development that make up the move from early preparation into realization.

Implementation

Community members are creating places to support an array of activities. Communal involvement includes considering construction details, fostering collaborative networks, creating places for investigation, and designing experiential spaces for gameplay. We have begun to plan for workshops and gatherings in the lab, inviting everyone from teachers coming for professional development to students ready for gaming to be a part of our programmatic offerings. We are pursuing funding through a variety of sources, including external grants and corporate partners, to help construct the initial lab and look ahead to upkeep and future modifications to the space.

Spaces. Currently we are in the midst of designing two locations comprising the physical space that will become the Digital Media & Learning Labs. *The Incuba*tor is a large room with four inter-related breakout rooms allowing collaboration with App and Game Development, Collaborative Writing, Video Production, and Audio Production. The Incubator allows access to games, production tools and platforms. *The Basement* is *a* "gaming in the wild" space. Its primary purpose is for experiential, social, unfettered game play. Gaming in *The Basement* may involve gamers participating in tournaments, online multiplayer games and exergaming using various platforms, devices, and gaming systems. This space focuses on play experiences, in-game decisions and choices, preferred environments, and modes of engagement that will inform research and practice within both labs. (Lab spaces are detailed at http://www.clemson.edu/centers-institutes/dmll/dml-labs.html).

Collaboration. We have begun developing research and curriculum projects that will use the offerings of the lab and extend our programmatic themes into other campus spaces and external environments such as schools and libraries. Collaborative research projects are underway between the Schools of Education and Computing, with plans to develop more partnerships in the future. For instance, a current interdisciplinary project involves faculty and graduate students from both schools considering how to merge design and development of games with learning theory.

Rethinking teaching and research. We have implemented undergraduate curricular changes that will take effect in the fall semester of 2013 and are in the planning stages of graduate coursework that will result in specialized degree offerings in areas of game design and digital media. We have found initial success in creating coursework and research projects related to DML with plans to grow. One of our core group members has offered a special-topics graduate course on games, social media, and digital technologies that will become a regular course in future semesters. "Games for Learning" and "Graduate Design" courses, pairing faculty with graduate students to design digital media integrated with pedagogy and curriculum, are in the works. We have revised the offerings for Teacher Education undergraduates from the previous one-credit courses focused on instructional technology training on a set of tools, to a more connected approach that considers pedagogy and tools related to creation, collaboration, communication and interest-driven participation. In the area of research, we have started a computational thinking project working with faculty in Human Centered Computing, to study at-risk middle school students using MIT App Inventor MIT App Inventor (http://appinventor.mit.edu/)as a means of promoting computational thinking. Similarly, in another project, we are using Alice, a 3-dimensional programming environment developed at Carnegie Mellon University, to support the development of computational thinking by allowing girls to program dance characters. Both of these endeavors have received internal grant support requiring collaboration across colleges. A grant awarded for creative inquiry of undergraduates supports student involvement from Architecture and Communications designing inviting, appropriate spaces and programs in the emerging DML lab, as well as helping with outreach across campus.

Extending the vision. Still in the early stages of our collective endeavor, we continue building on our preliminary plans and negotiating new issues and hurdles as they arise. Initially, we relied on internal audiences to share our vision, inviting administrators and faculty to join our discussions of DML in the context of their professional work. For instance, a recent reading and discussion group included Jenkins et al., research on new media literacies and potential impact on practice. We have hosted workshops, held planning retreats, and sought out every opportunity to meet with faculty and students external to our core group. Sharing this working example is one of our first opportunities to present our ideas to a group of colleagues with the hope of fruitful discussion and productive feedback about our plans and progress.

In addition to discussing our work with like-minded colleagues and stakeholders within and beyond our university, we hope to join the ongoing conversations about Digital Media & Learning, Connected Learning, Participatory Culture, and related topics by sharing our work through social media channels and a contributory web presence.

Reflecting and Looking Forward

In this final section, we present some of our initial reflections and our future plans. Significant factors contributing to challenges and successes are outlined as a means to offer suggestions, pursue input from interested colleagues, and consider alternatives through solicited constructive critique.

Realizations and Unanticipated Challenges

We are working within the framework of a public, land-grant university that has a long and complex history and vital connection to its region. Institutional structures have developed over many years and traditional patterns of engagement by faculty existed prior to the arrival of many of our core group members on campus. Understanding the impact of these factors to instill change and foster a cultural shift has been an important part of our acclimation to this context. To that end, we have come to know the related stakeholders and have made a concerted effort to learn their roles in the university hierarchy, their perspectives on interdisciplinary collaboration, their dispositions toward DML, and their propensity for change. While none of these points can be considered earth-shattering realizations, we have a newfound respect for understanding context and the accompanying limitations present in any new environment.

Although we anticipated the typical challenges related to negotiating funding, infrastructure, and human capital, we were somewhat unprepared for some pockets of resistance from members of the university community. This has served to remind us of the importance of creating a shared understanding and being prepared to defend the importance of our mission through data and exemplars. For example, an unexpected change in administration impacted initial plans for the Digital Media & Learning Lab forcing us to return to our proposal and provide supporting documentation and requisite rationalizations for decisions. Demonstrating in-progress, authentic examples from P-12 educators using innovative pedagogical approaches supported by technology, along with connected learning (Ito et al., 2012) approaches at similar universities has served to broaden perspectives.

Overall, and fortunately, our setbacks thus far have been minor and have all served to strengthen our ideas, remind us to consistently reflect on our plans, and develop important connections within and external to the university community.

Initial Success and Continued Learning

We are in the planning stage of our physical space, and will undergo construction in Summer 2013. We have started several research projects with more to follow, we have laid plans for new course and degree offerings, and we have engaged faculty members from diverse academic areas in our work. We taught and will teach courses focused on DML and have implemented changes to pre-professional curriculum that are in place for the next academic year. These initial successes have provided us with important lessons about our work and a great deal of excitement moving forward.

For those looking to undertake similar endeavors, we have relied on work from the Digital Media & Learning Research Hub, James Gee, Henry Jenkins, and the Connected Learning Research Network, as well as other work supported by the MacArthur Foundation. We appreciate their contributions to our field and ongoing role in our current endeavor.

Invitation

As a working example, we invite your participation in this ongoing work. Our continued commitment to the field includes connecting with others physically and virtually via shared discussions, workshops, events, and coursework. Further sharing and communicating via images, documents, and short participant videos will be offered as “plausibility proofs” (Barab, Akran, & Ingram-Goble, 2012) on the Working Examples website (http://www.workingexamples.org/). We began our long-term undertaking by attempting to learn from those who have done similar work before us, and by inviting a broad range of interested people from a broad range of academic backgrounds to join our conversation. Extending our work to scholars and practitioners within and beyond the DML community for continued involvement, critique, and participation is both welcome and necessary.

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Creating a Collaborative Online Resource for Integrating Videogames into the Composition Classroom

Luke Thominet, Wayne State University, Ez7398@wayne.edu

Abstract: In fall 2012, I developed the first draft of *Videogames + Composition* on methods for integrating videogames into first year composition classrooms. By creating a taxonomy of methods and by reflecting on a collection of lesson plans, the website is designed to help instructors explore the range of possibilities for this technique. The ultimate goal, however, is to create a model for pedagogical collaboration networks. In this paper, I discuss both the content and building process of the site

I began developing *Composition* + *Videogames* (Thominet, 2012) last year as a resource for composition instructors who are looking to integrate videogames into their course design: (see Fig. 1). I came to the idea of creating this site through an initial interest in the pedagogical technique. After reading Gee's (2005) article, "Good Games and Good Learning," I was struck by how his theories could help in counteracting the generalized student apathy I noticed while teaching. However, I also believed that integrating videogames into my courses would be an initially difficult experiment and that it might meet with some departmental resistance, so I began to look for further information. As I searched the web, I ran into two distinct problems: 1) a lot had been written about why videogame integration could be a good idea, but very little existed to show exactly how it could be done, and 2) what little had been written about application was spread diffusely among many sites and it was written about idosycratically about what individual instructors had done with little reflection and no peer review on how the application could be improved to better meet the goals of effective pedagogical practice. It occurred to me how much was being wasted in these diffuse, scattered quests towards the same goal—in pedagogical circles, so much effort goes into continually rebuilding the wheel. Each instructor creates existing lessons anew (albeit with small variations) with each class design. What's worse, this diffusion of lesson planning can also restrict instructors from aspiring to more complex or novel methodologies for ones which have been more locally battletested.

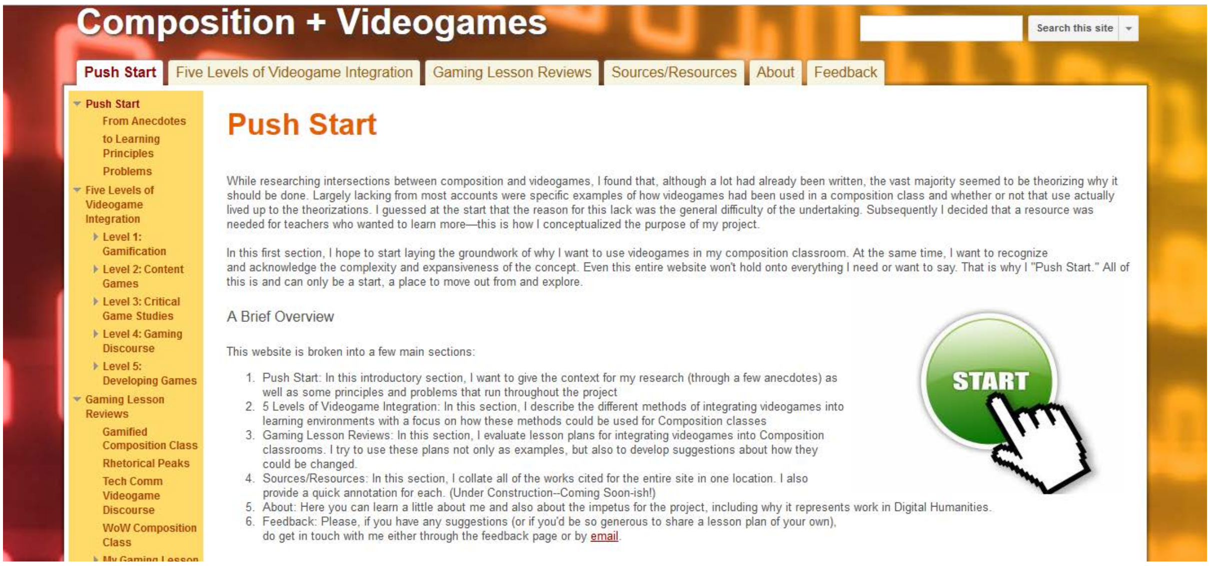

Fig 1: Website Homepage

Therefore, I wanted to create something that was publically available (online) and that could break down the available options in a way that was accessible. Additionally, my ideal end was the orientation of a pedagogical community or network of ongoing collaboration around the resource so that it could expand further. Ultimately, my design acts as a unique digital publication in a number of ways. First, it organizes the methods of videogame integration into composition classrooms in a way that has not been developed previously. Second, it collects and juxtaposes variously publically available examples of videogame integration while also reflecting within the framework on the strengths and weaknesses of each. In this way, I also turn scrutiny on my own sample lesson plans that were designed with my framework in mind. Third, the site is intended to reach out and create a participatory space for collaborative thinking.

The Website

Videogames + Composition is directed primarily at instructors who are already interested in the topic, but want to explore some ideas on how it can be done. To this end, the website is broken into 4 main sections (see Fig 2): an introductory background, a taxonomy of five methods of integration, a review of existing lesson plans, and a bibliography of further resources.

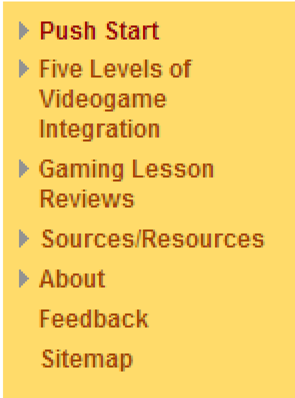

Fig 2: Website Navigation Bar

The primary framework for the analysis of methods and composition lessons in the project was James Paul Gee's learning principles. For the sake of simplicity, I turned to a shortened version of his published in "Good Games, the Human Mind, and Good Learning" (Gee 2007a). While, at first blush, this form of analysis might seem as a suggestion to judge the integration of games by a theory of integrating games, that is not the case. Gee (2007b) stated:

> I know that many people who have read this book take it to be an argument for using games in schools or other education settings. However that is not the argument I have tried to make in this book. I have first wanted to argue that good video games build into their very designs good learning principles and that we should use these principles, with or without games, in schools, workplaces, and other learning sites. Second, I have wanted to argue that when young people are interacting with video games--and popular cultural practices--they are learning, and learning in deep ways (p. 215)

In my commonsense extension of Gee's claims, my working hypothesis became that for videogame-integrated composition lessons to be successful, they would need to be gamic in nature. In other words, they would need to function primarily through the effective learning principles that Gee identified. So this became the root of the problem: how do we create a composition curriculum around videogames that keeps intact the beneficial learning opportunities offered by games?

In practice, this means that my goal is not simply to propagate composition projects that involve analyzing videogames as a replacement for other, more traditional texts. It also means that I am not interested in a simple application of videogame terms to existing pedagogical methods in composition studies. At the same time, I feel that it is unwise to reject, out of hand, any method that might add to the cogence and reach of the class, which is why, in the categorization of methodologies that follows, I will include the aforementioned pedagogical uses of videogames. However, what I found to be most important is that methods were used in concert with each other create a tightly interwoven lesson design.

A Brief Overview of the Methods

On the website, I create a taxonomy of methods of videogame integration. The organization of these methods is of my own design, but the concepts are derived from research into the topic. Ultimately, I developed the taxonomy by investigating how various scholars were talking about using games in classrooms and how instructors were implanting game integration (these authors are described in more depth on the website) and then by searching for similarities in theories and applications. This is to say that I did not create the methods themselves, but only identified and organized them in this way. While the website describes these methods specifically as ways of integrating videogames into a first year composition classroom, many of them could easily be expanded to address videogame integration in a variety of classroom settings.

Method 1: Gamification

> Gamification refers to the process of adding game elements to non-gaming activities. In practice, this typically means giving non-standard awards or evaluations in non-gaming environments. For example, a teacher might give a badge or a level to a student rather than a grade. The process is often more about creating a new conceptualization of the non-gaming environment, to effectively make it seem more enjoyable. (Thominet, 2012)

Many scholars have spoken about gamification (or creating gameful classrooms) as a means of defamiliarizing the classroom environment. Initially, this method shows some promise as a means of reorienting student expectations, and thereby combatting student apathy. Regardless, my impressions of gamification in the classroom are not terribly positive. Rather than opening up playfulness or even making use of the principles described by Gee, gamified classrooms may change little more than the words used to describe existing classroom practices. It is only when these terms introduce new practices that they can contribute constructively to student learning. For example, reorienting evaluation around particular achievements (such as developing an excellent thesis or making a thoughtful revision) and allowing students to choose among multiple semester-long quests (such as publishing a fleshed out and convincing argument in a publicly accessible location) in their own way and at their own pace, could create an atmosphere that encourages students to customize their experience to their own current skill level.

Method 2: Content Games

> The earliest way many of us were introduced to games in the classroom was through content games or "edutainment." My childhood memories are rife with Number Munchers, Oregon Trail and Reader Rabbit. As in these examples, this type of games purports to teach specific information. In most classroom environments, instructors first figure out what they need to teach (which is usually determined by written institutional expectations) and only then decide how they will teach it. Content games come into this process in the method step by reconfiguring old lesson plans into the form of interactive digital media. (Thominet, 2012)

Creating a content game for a composition class would not be easy. The most obvious answer would be to build a game around lower order composition concerns such as mechanics, grammar, and punctuation. Among others, I have been working towards this in developing interactive tutorials for my university's writing center. Many similar tutorials of varying quality already exist, but in my own designs, I've aimed at providing a structured lesson plan with multiple paths that helps build students from initial recall of information to more complex and freeform applications. Still, these tutorials fall short in two ways. First, as games, few tutorials actually develop any distinct level of learner playfulness or investment. Instead, they often reside in a more traditional conception of learning as information banking. I don't mean to discredit my own work or others in this way, as I do see value in these tutorials and in working to develop strategies for creating them, but they simply aren't full games yet. Second, and more important, in focusing on lower order concerns, most tutorials aren't actually teaching the true content of a composition class as it is currently conceptualized. If they desired to do this, they would instead have to focus on much more complex rhetorical situations that are difficult to capture effectively with the limited interactive features offered by most commercial tutorial builders. Once again, I have been trying to design around this problem by focusing some of our tutorial on more complex tasks and by looking at Peter Shea & Jim Grenier's (2012) work on Rhetsims, which are interactive texts used to help developmental writers create essays in response to a prompt prior to having the full range of writing capabilities to perform the task on their own.

Also of interest is *Rhetorical Peaks*, which was developed by graduate students by the University of Texas at Austin. It was discussed by Anthony Matteo (2007) and Matt King (2008). The primary concept of the game was to provide a situation in which students could analyze the rhetorical strategies of various non-player characters and subsequently write an argumentative piece situated within the context of the game. While my review of the game critiques its text-heavy format and its limited interactive capabilities (thus also limited its effectiveness as a game), *Rhetorical Peaks* does suggest how we might begin to pursue content games for composition courses.

Method 3: Critical Game Studies

> Critical Game Studies focuses on the close analysis of how games actually function. The goal is often to understand more about what makes the genre unique. As James Paul Gee said (2007a), "Next to nothing is good or bad for you in and of itself and all by itself. It all depends on how it is used and the context in which it is used. ... So good video games are good for your soul when you play them with thought, reflection and engagement with the world around you" (pg. 8). The "proper" way to play games is the same as the "proper" way to read a text or to watch a movie: namely,

> to do so actively and critically. Videogames are particularly prone to “improper” play because of the level of involvement that of a player in creating the text, as well as the unrelenting flow of content. If time isn’t set aside to think about the game and how it is acting within a particular space, important features/world-views/discourses can go by unnoticed (Thominet, 2012).

Critical Games Studies is likely the most common way that videogames are used in composition classrooms. Rather than building an analysis around a more traditional text (such as a book or article), instructors have used videogames as the focus of an analysis or argumentation assignment. By analyzing videogames, students might come to better understand a media that they tend to take for granted. Additionally, videogames can provide a complex rhetorical object for analysis because of because of their inconsistent form (which is due to the player interaction). This, of course, could be seen as either a positive or a negative feature of using games this way. Perhaps it could distract too much from the real purpose of the exercise (which is likely to develop students’ strategies for approaching a school text critically), but it might also, in much the same way as other multimodal exercises have, improve the students’ understanding of the wider applicability of such an analysis in their own lives.

However, like the previous examples, this method could easily lack that very gamic quality that is being sought after in the integration of videogames. Simply replacing one text with another does little to alter the underlying structure of the learning process. Certainly, it is possible that students will become more engaged with a videogame than with an 18th century novel, but actively reading a game is not engaging in the same way as playing it casually. It is my assumption that this method, if used alone, would not have a significantly different result in terms of student learning or engagement than what could be achieved with a more traditional assignment.

Method 4: Gaming Discourse

> The idea of communication taking place within discourse communities has been an essential strain of composition theory for some time. Charles Bazerman (2009) defined a discourse community as “a grouping of people who share common language norms, characteristics, patterns, or practices as a consequence of their ongoing communications and identification with each other.” This is what I am talking about with the idea of a gaming discourse: namely that through active use of language within a situated context, students can develop knowledge of communication strategies as well as a meta-awareness of the ways in which that knowledge is structured by context (Thominet, 2012).

Speaking more plainly, this section highlighted a coalescence of two related methods. In the first, students would be given a game whose content was a simulation of a workplace or other nonacademic environment. In this case, the writing produced by these students would be connected to the professional practices of the simulated environment. In this way, it would hopefully overcome some of the transfer difficulties students face when moving between academic and nonacademic settings. This method is discussed at length by David Shaffer et al. (2011) in their exploration of epistemic games. In their study, they introduced first year students to an engineering simulation called Nephrotex. Their preliminary results showed that, by encouraging engagement, this simulation helped students to better grasp engineering content and to think more like an engineer. Extending this concept to composition classes, we can see how it might assist instructors in developing realistic environments for writing across the curriculum.

The other form of gaming discourse is much more closely tied to the traditional composition assignment. In connection with playing a commercial game, students would be assigned with creating texts for the vibrant player-communities that typically surround such games, texts such as reviews, faqs, focused strategy guides, or trouble shooting guides. Anne Richards and Adrienne Lamberti (2007) explored this method and developed a breakdown of different genres used by gamers, including: strategy guides, printed charts, electronic tutorials, and guild forums among others (pg. 13).

Notably, their list of genres included both texts that are created by the game developer and those created by the players. So, in thinking about the discourse community surrounding games and the possible exercises in a composition classroom, we can begin by looking at this range of genres as a way for students to write for an active discourse community.

There are, perhaps, as in all the previous examples, also some drawbacks to this method. Neither example explicitly requires the playful engagement desired (simulations can be tedious and writing for gaming discourse communities might seem as alien to some students as writing for academic journals). However, these two methods still can encourage an, at least, seemingly authentic participation in a discourse community—something that can become a struggle in traditional composition settings where students always already write for their instructors eyes only.

Method 5: Developing Games

> Developing games in a composition classroom can take several possible forms. It could focus on game design, programming, interactive fiction, or some combination of the above, though each of these is likely to cause a considerable amount of criticism within the field. For now, it should be enough to say that this is the least explored method of integrating videogames into the composition classroom because it is both difficult and largely divergent from traditional composition classroom activities (Thominet, 2012).

Developing games is exactly what it sounds like: directing students in the composition of videogames for various purposes. An instructor might do this in a movement toward a fully multimodal form or composition, or, perhaps, as a means to assist students in better understanding the makeup of videogames. (The second of these options could likely be connected to a project in critical game studies.) Regardless, as mentioned above, various options exist for integrating game development, each with potential technological difficulties and with varying focuses. The game design sub-method focuses primarily on exploring the functioning of games, irrespective of technology. It often takes place as a creation of non-digital games (board, card, etc.) to explore the underlying structure of these objects. Programming, the most highly technological of the three sub-methods, directly addresses the language of computer games. As such, its lesson content would reflect computer science more than traditional English composition, but knowledge of programming syntax is invaluable to considering the functioning of videogames as technology. Finally, interactive narratives try to toe the middle line. They focus less intently on either games or technology, but instead try to interrogate (in an approachable manner) the intersections between the two. Often this type of lesson can be carried out with the assistance of toolkits included in some commercial game releases.

Speaking in depth about the criticisms of this method here is likely unnecessary. As it does not seek to directly instruct students in English Language Composition, it can be seen as an unnecessary distraction (by untrained instructors) from the real purpose of the course. These objections might be overcome (while necessitating far greater depth of discussion) with appeals to multimodal composition, to critical thinking about contemporary texts, or even to the benefit of critical attention to syntax.

Lesson Reviews

At the heart of my attempt to make teaching with videogames a more approachable task for composition instructors, was the need to provide direct and varied examples of how this had been or could be attempted. However, once I began to explore past lesson plans, I found that, in many cases, they simply did not match up well with the learning principles for good videogame-based pedagogy. To this end, I structured my reviews into three sections: 1) an introductory listing of applicable learning principles and methodologies involved, 2) a summary and critique of the lesson, and 3) a review of the major strengths and weaknesses of the lesson. I derived this format from typical videogame reviews, which often begin with a statistical breakdown of the game (# of players, genre, etc.) and which often end with bulleted highlights.

For example, in a lesson plan I developed myself (in the limited examples I currently have, I pulled fairly evenly from my own mind and from publically posted lesson plans developed by others), I sought for a way to connect *L.A. Noire* (2011), with rhetorical analyses typically taught in composition classrooms. My “lesson preview” opens with a bullet pointed list: (see Fig. 3). The primary goal here is to layout information that will help instructors quickly evaluate the possibilities (and benefits) of plugging this type of lesson plan into the class.

Rhetoric and L.A. Noire

Lesson Time: 2+ Weeks
Learning Principles: Co-design, Customization, Identity, Distributed Knolwedge, Cycles of Expertise, Sandboxes, Skills as Strategies, System Thinking
Videogame Methods: Content Games ,Critical Game Studies, Developing Games, Possibly Gaming Discourse Community

L.A. Noire is a videogame for Xbox, Playstation 3, and Windows that was released by Rockstar Games (the publisher famous for the *Grand Theft Auto* series). In *L.A. Noire,* players take the role of a police detective in 1947 as he investigates a series of crimes. While the game features an open world map that the players can move around and explore as they like, it also has a strong main plot that directs most of the action and progress. The primary gameplay is connected to the investigations. First a player moves around the crime scene, looking at objects and (hopefully) collecting clues. Then the player can interrogate witnesses, who are often trying to withhold the whole truth. In these interrogations, players are given three options for interaction, they can accept the statement as truth, they can doubt the statement, or they can openly challenge it as a lie. The choice among these three options is determined by the evidence that the player has found. Doubting a statement is useful when that statement can't directly be proven untrue. Often there are multiple witnesses to interrogate for each crime. Successfully completing the mission and solving the crime requires a certain amount of successful interrogation.

Fig. 3: Lesson Preview for L.A. Noire and Rhetoric

The actual lesson follows, laying out the intent and a general description of the assignment program. In this case, students would initially focus on the procedural aspects of the game's interrogation system (which is built in branching dialogue trees based on character knowledge and player choice) by exploring programming language structure and then applying its procedural aspects to an exercise in standard English (where dialogue is built through input and output). Next they would be tasked with building a rhetorical analysis of the game, combining attention to the procedural aspects of the game and the traditional rhetorical aspects (rhetorical triangle, stasis theory, etc.) of character interaction within the game. Finally, the use of this text could be further expanded with students creating argumentative pieces reviewing the game or comparing it to its apparent parentage (noire films or pulp detective novels). In this way, the videogame could provide the basis for a series of major assignments in a composition class while allowing for some play in the range the selection of writing goals.

Finally, the review ends with a succinct listing of my own perspective on the lesson, including strengths (such as a wide range of possible assignments) and weaknesses (such as the limited range of rhetorical interactions available in the game): (see Fig. 4). I see this section as a way to summarize pedagogical reflection in an accessible format.

Strengths of Lesson:

- Focus on creating a featuring rhetoric
- Wide range of writing assignments
- Can help students become actively involved in use of rhetoric

Weaknesses of Lesson:

- Game has high system requirements
- Interaction in actual game is fairly simplistic

Fig. 4: Summarized Strengths and Weaknesses

Conclusion

As I said at the start, this project is, as of yet, unfinished. While I have a workable draft of all the parts, I do not feel that it has reached the critical level of content to be the resource I want it to be. To begin with, the lesson plan reviews need to be greatly expanded. Ideally, this would occur through the solicitation of both successful and ineffective lesson plans from instructors across the nation. In order to achieve this, I will not only need to publicize the site to interested parties, but also to create a set of guidelines for submission. These might include the requirement that all instructors also provide a reflection of the effectiveness of their own lesson in addition to the information currently found in each review. This could be further supplemented by peer review and rating of the lessons. Furthermore, I would look to expand the links between the website and valuable outside resources. Finally, I've also come to the conclusion that the site will need to be migrated to a more robust platform. This is for two reasons: 1) I would like to develop more intertextual connections through metadata tagging to subvert the current linear organization of the site, and 2) I need a platform that allows for a wider range of community interaction. Additional suggestions were offered by the audience at my presentation on this topic, which included: 1) adding a number of new resources on balancing the time requirements of institutional standards for the writing course and appropriate pedagogical integration of videogames and 2) creating centralized suggestions for typical assignments (such as a list of successful questions for student analyses of games).

Ultimately, it is my belief that the website, even in its current state, holds the seeds for a productive expansion of videogame integration in composition classrooms. But this isn't my final goal. Instead, I want to continue to explore the means for creating productive pedagogical networks across institutions. In creating these spaces for collaboration, we might be able to strike faster into the future of innovative pedagogical techniques. Certainly this is shooting high for my meager project, but, as Jane McGonigal (2010) said, great games have the possibility of an epic win.

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The Time a Tablet Game Walked Into an Early-Learning Curriculum Framework

Jessica Tsang, Dylan Arena, Kidaptive, Inc.
jtsang@kidaptive.com, darena@stanford.edu

Abstract: As a worked example, researchers explicate the process of designing a comprehensive early-learning curriculum framework to support a series of tablet-based interactive animated stories, along with a parental feedback loop.

Introduction

In this worked example we will explicate our process for developing a comprehensive early-learning curriculum framework to undergird a product offering that includes (a) animated stories with embedded games and puzzles to be deployed on tablets (Arena, Gunsagar, & Sharples, 2012) and (b) parental feedback and guidance about how to support learners' progress. This development was in a commercial rather than a research context, so our concerns and priorities may not fully mirror those of our colleagues in academia. Our own academic backgrounds, however, compelled us to hew closely to research-based early-learning literature as we developed our curriculum. Furthermore, our goal of producing something that is both authoritative and easily understandable to a lay audience is one that many academics who want to broaden the impact of their work may share. And finally, one of the primary aims of the worked/working examples movement is to promote communication and understanding across disciplinary boundaries (Gee, 2010): The boundary between industry and academia is surely a fitting one to try to cross.

We will examine three main aspects of our development process in this paper. First, we will describe how we "sourced" our curriculum (i.e., what resources and expertise we relied upon to establish a *comprehensive* and *authoritative* curriculum) and present briefly the results of this effort. Next, we will explain why having a *comprehensive* and *authoritative* curriculum was a design goal in the first place. And third, we will discuss the ecosystem we hope to create around this curriculum.

Our Sources and Sages, and the Resulting Curriculum

The authors of this paper are learning scientists, but neither of us focuses specifically on early learning. (Simply having young children, it turns out, does not make one an expert: One's own children only inconsistently behave in generalizable ways.) So our first step was to cultivate a relationship with a master preschool teacher and lecturer on early child development at our local university. In the spirit of reflection that the worked-example movement is meant to embrace, we should note that this simple act of social connection may have been our single most fruitful research step. Our master teacher helped us capture every set of research findings, standards, guidelines, and best practices for early learning that might possibly be relevant while also steering our attention away from lower-quality materials. (Too much data, as researchers in this information age know all too well, can be its own curse.)

We synthesized this diverse literature, which included several state-level and a few national-level standards documents (e.g., California Department of Education, Child Development Division, 2008; California Department of Education, Child Development Division, 2010; Pennsylvania Department of Education and Department of Public Welfare, Office of Child Development and Early Learning, 2010; U.S. Department of Health and Human Services, Administration for Children and Families, Office of Head Start, 2010) as well as key papers from developmental psychology and learning sciences (Brown & Kane, 1988; Duncker, 1945; Mischel, Ebbesen, & Raskoff Zeiss, 1972), into a set of key elements that most or all of our sources agreed were important for optimal development of young children. These elements spanned cognitive, social, emotional, physical, and academic categories of competency, so at first we were tempted to recapitulate these categories in our curriculum organization. But here, our lay-customer-facing context forced us to ask ourselves not how we as researchers might parse things but how we could most compellingly communicate the elements of our curriculum to busy parents of preschool-age children. Adopting this more pragmatic lens helped us to carve our curriculum into the following seven "clusters":

1. *Control Yourself*: This cluster includes executive function (De Luca & Leventer, 2008; Espy, 2004), emotional control, motor control, and patience (which, we admit, can be thought of as falling under executive function, but the concept is recognizable enough to parents that we thought it warranted separate mention).

2. *Figure Stuff Out*: This is our “problem-solving” cluster. It includes categories for understanding relationships, representations, the structure of the world, planning, and spatial reasoning.

3. *Acquire Physical Routines*: Kids have a lot to learn in the physical realm. We categorized elements in this cluster in terms of movement (e.g., pencil grip), space (e.g., body awareness), or tasks (e.g., washing hands).

4. *Be Creative*: This cluster includes divergent thinking (e.g., thinking of 10 different ways to use a popsicle stick), self-expression (painting, building, etc.), and generative thinking (e.g., thinking of 10 different things to do on a Saturday morning).

5. *Gather Necessary Knowledge*: This cluster captures what many people think of when they think of early learning: colors, shapes, ABCs, 123s, etc. One of our criteria for the success of our curriculum is that people who explore it come to understand that this cluster is only a small subset of what matters for young children’s development.

6. *Love Learning*: This cluster captures such trendy psychological topics as deliberate practice (Ericsson, Krampe, & Tesch-Römer, 1993), grit (Duckworth, Peterson, Matthews, & Kelly, 2007), intrinsic motivation (Ryan & Deci, 2000), and growth mindset (Dweck, 2007).

7. *Interact with Others*: Of course, we do not live, learn, or develop in a vacuum. This cluster includes categories dealing with boundaries, communication, and other important elements of social interaction.

These seven clusters are the top level of a hierarchical curriculum that includes over 80 dimensions of learning. We believe that the curriculum does a fair job of describing all of the skills and knowledge children need in order to be prepared to learn well in all of the various formal and informal learning situations they may encounter as they grow. But it is *daunting*. As the reader may guess, our goal of producing a comprehensive and authoritative curriculum framework stands in tension with our goal of producing a curriculum framework that busy parents who are not experts in developmental psychology can understand. The straightforward names of our seven clusters should help, but we also decided to create a visualization to help parents navigate up and down through the levels of the curriculum framework. This visualization is designed to be used on tablets, as part of the same app ecosystem as our interactive animated stories for children (about which more will be said below). Figure 1 shows a drill down process from *interact with others* into *communicating*, which contains individual dimensions such as *verbal language comprehension* and *play entry skills*. Tapping on any of these individual dimensions will give the parent a brief description of that dimension and, if necessary, its relevance for early learning.

Why Go to all That Trouble?

As noted above, we are industry researchers creating interactive animated stories on tablets for preschoolers, along with a parental feedback and guidance framework. The games we incorporate into our stories serve as embedded assessments to measure learners’ progress on relevant curricular dimensions (e.g., color identification or spatial reasoning). We can report that progress to parents and give them tips about how to support that progress outside of tablet time. Given this product model, why would we bother including curricular dimensions that cannot feasibly be measured in our games, such as the ability to hold a pencil correctly or verbally articulate one’s needs?

There are a few reasons. First, as academic completists, we wanted to be sure we had considered all relevant aspects of early learning in our own research process. Once we had done so, we realized that we could use the breadth of the curriculum framework as a design support to help us think creatively about what we might possibly incorporate into gameplay. For example, we have created games to measure and foster turn taking, facial-emotion identification, and delay of gratification; developing workable game mechanics to support those dimensions was not easy, and it might not have occurred to us to try had we not kept the dimensions in our curriculum framework as we brainstormed game ideas.

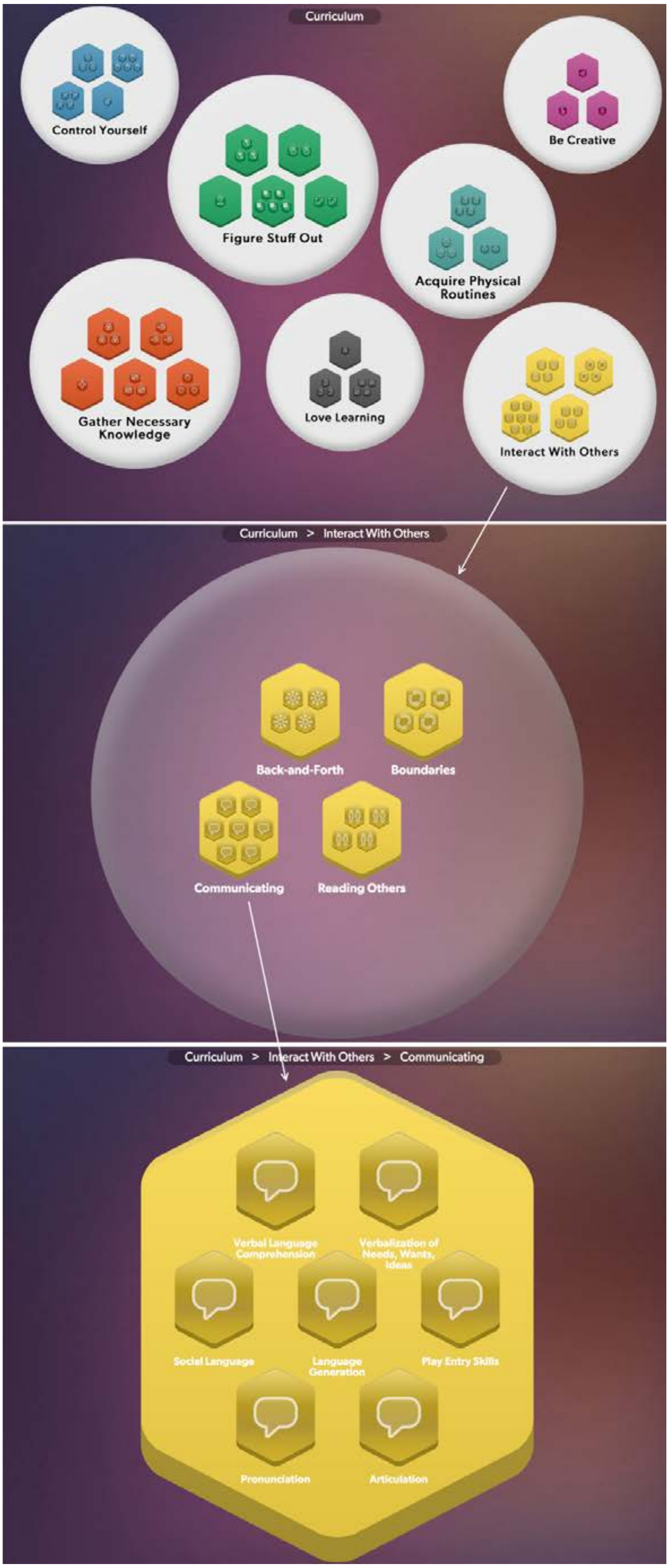

Figure 1: Curriculum Framework and Drill-down

Second, as a young startup trying to establish a brand identity, we recognize that our academic background can help differentiate us from our competitors. Being able to offer parents a complete picture of what their children will need to succeed as learners—even if that picture includes things we cannot directly support in our products—may help establish us as a trusted resource in the minds of those parents.

And third, we recognize that learning is an all-the-time activity. We create products for tablets because the affordances of these devices have made them a prominent part of the new-media landscape for preschoolers, but we recognize that most learning will (and should!) still occur in offline contexts. To effect real change in young learners' trajectories, our goal must be to create a connected learning ecosystem (Ito, 2013).

Three-Pronged Delivery Plan

The ecosystem we hope to create has three interwoven parts: our stories, our interactive elements, and offline parental support. The stories provide the narrative backbone for our curricular ecosystem. Each "appisode" in our product line is a tablet app containing a cartoon story, and each story has a theme, such as perseverance or divergent thinking. We use the stories to present aspects of our curriculum framework that are amenable to modeling (such as describing one's feelings or negotiating social conflicts) or direct instruction (such as teaching vocabulary in context).

Each story also has 4 to 6 games, puzzles, or other interactive elements incorporated organically into the story. For example, in the first story in our series, the main character is preparing to attend a friend's birthday party; as part of that preparation, he must build a present for his friend (which leads to a puzzle game) and make a birthday card (which leads to a painting activity). These interactive elements may measure learner achievement in a dimension (e.g., the puzzle game measures spatial reasoning and motor control) or simply support development in that dimension (e.g., the painting activity provides an opportunity for creative expression). Our design goal with these interactive elements is to keep them situated in the context of the narrative, so that learners always understand why they are doing various tasks and are motivated to succeed to propel the story forward.

Most of our interactive elements are embedded assessments that measure various curricular dimensions. We report those measurements to parents through an interactive dashboard (detailed discussion of which is outside the scope of this paper), and we offer specific research-based advice to parents about how to support their learner's progress in the relevant dimensions at home, in the car, etc. For example, we might measure a learner's ability to identify colors by name in the context of a hide-and-seek game or a rocket-fuel-mixing game and conclude that the learner consistently identifies primary colors but struggles with secondary and tertiary colors. And then in reporting that to parents, we might explain a recent research finding (Dye, 2010) suggesting that when teaching color names, it is better to say the color name after the object name rather than before (e.g., "the balloon is red" instead of "the red balloon").

This reporting-and-advice functionality feeds into the third part of our ecosystem, offline parental support, which is both the most important and the one over which we have the least control. Our stories, too, are intended to foster off-line parental support, insofar as learners' engagement with story elements can till the soil for future parental interactions. For example, a child who has just experienced an interactive story about helping characters to catch a magical fish may be more receptive to and prepared to learn about things like how animals play different roles in an ecosystem, the history of fishing, how different cultures catch and use fish differently, or even the physics behind a fishing-pole reel! In this case, the story creates a micro-interest that can parents can leverage to help the child learn about history, society, biology, or physics.

Reflections

Whether parents actively want technology-based education for their kids or simply recognize that their kids will use technology and that they may as well try to make those experiences as educational as possible, many parents today are exploring tablet-based early-learning options for their children. And regardless of people's opinion about the rightful place of technology in early learning, most agree that tablets can convey some lessons but not all. Parents want to understand how to support their learners, both within a new-media ecosystem and more broadly. These facts create a messaging opportunity. We have tried to design our curriculum framework to respond to this messaging opportunity by offering a way for parents to explore the space of early learning and to understand what is (and is not) important in this space. (We are continually surprised by how many parents stress about how quickly their three-year-olds will learn to read, for example, and we hope that many more parents will come to understand the importance of executive functions to their learners' long-term success.) And in light of our beliefs about connected learning, we have found the breadth of our curriculum to help us keep a broad view while we design various nodes of the network, which we hope will help those nodes fit more harmoniously into the whole.

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Working Examples: Come Play with Us!

Jolene Zywica, Anna Roberts, Drew Davidson, Carnegie Mellon University
Eric Keylor, Jim Gee, Arizona State University
jolene.zywica@workingexamples.org, anna.roberts@workingexamples.org, drew@andrew.cmu.edu, ekeylor@gmail.com, james.gee@asu.edu

Abstract: Working Examples (www.workingexamples.org) is a community that bolsters innovation and the potential impact of your work. You share and improve your ideas through exposure to new perspectives from researchers, designers, educators and funders working across the field. We come together around 'Examples' (ideas, work and projects) to explore new ideas, learn from each other, collaborate and impact the future of education. Our GLS session kicked off the Working Examples thread of presentations and covered four major problems the site is designed to address. Working Examples was intentionally designed to build a diverse community of practice, support sharing of work-in-progress, connect research, design and practice, and shift how we publish the work we do. We wrapped up with a call to action: Get on the site, share your work-in-progress, and collaborate to create something truly innovative.

So…What Is WEx?

Working Examples (WEx, www.workingexamples.org) is a community that bolsters innovation and the potential impact of your work. You share and improve your ideas through exposure to new perspectives from researchers, designers, educators and funders working across the field. We come together around 'Examples' (ideas, work and projects) to explore new ideas, learn from each other, collaborate and impact the future of education.

We like to think of WEx as a sandbox; it's a community based around building and improving ideas about technology and learning (e.g. games for learning) by sharing your work-in-progress and introducing yourself to new people and perspectives. WEx is a tool for impacting the world in spite of 'the system'. The site's broad audience is useful for getting critiques and feedback on your ideas or for finding resources such as play testers, subject matter experts and funding. You help others with their work by sharing your game design documents, production techniques, evaluation methods, postmortems, or lesson plans. Sharing this documentation will also help you to think through your process and improve your own designs.

The WEx community's beta site was launched in 2011. We spent 2012 redesigning the site based on community feedback and reworking the design to provide better interaction. The new site launched in March 2013 and offers a unique space for game researchers, designers, developers and educators to connect, collaborate, and share work-in-progress. WEx can be used to cultivate best practices for game design, teaching with games and publishing games at different stages of development.

A Bit About Examples

Working Examples are demonstrations of what the author believes to be good work (Barab, Dodge & Gee, 2009). Gee (2010) argues that such examples can be used to collaboratively define and develop the field of digital media and learning, which includes games for learning. Examples are ways to test ideas early in development and to get research and design out in the open.

In the WEx community, users and teams post Examples, ranging from preliminary ideas (or "seeds") to ideas that have "sprouted" and "bloomed" into developed projects. An Example might document the creation of a video game (e.g. "Space Vector 2.0: A Video Game for Beginning Physics", (http://www.workingexamples.org/example/show/42), demonstrate how to assess learning from game play (e.g. "Crayon Physics--Assessing Creativity, Persistence, and Conceptual Physics", (http://www.workingexamples.org/example/show/102), or show how to implement games in educational settings. Examples are intended to be more than just text documents, and can include concept art, storyboards, preliminary game documents, lesson plans, videos, images, and activities—anything that could be helpful to tell the story of your work (See Figure 1).

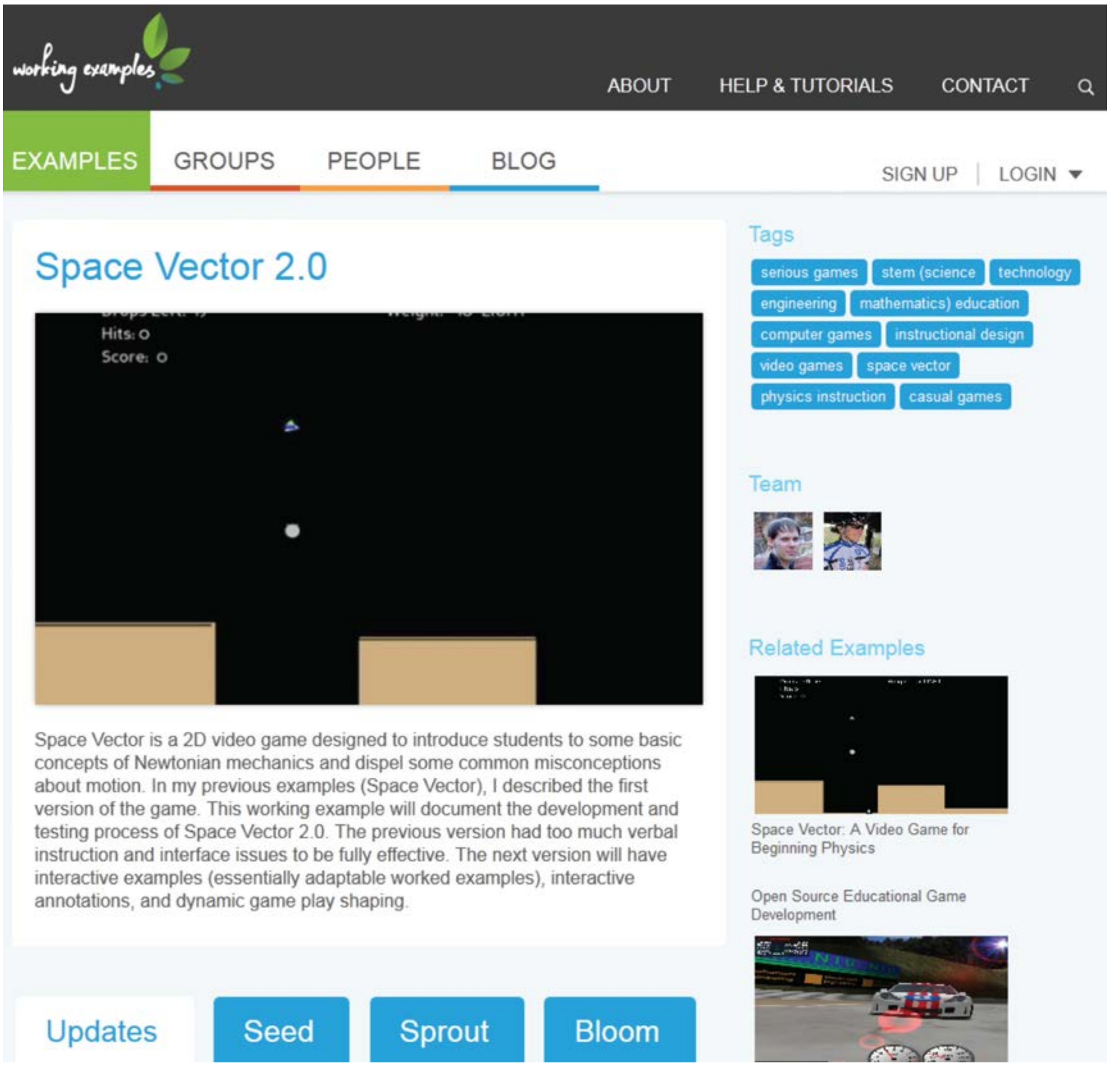

Figure 1: "Space Vector 2.0" Example Page.

Intentional Design

Good design is a mindset; it's an intentional process that spans from research to implementation. Working Examples is built to encourage and facilitate good design practice; to help people create work that will better impact the learners that we care about so much.

As a field, our collective design process needs some work. We don't often think of ourselves as part of a larger process. It's hard to find the time and resources to reach out and engage with one another; so we focus on our own ideas and outcomes instead. But the result is less impact—research that doesn't leave academia, games that don't get to their audience, or curriculum that stays in one classroom.

There are four roadblocks to impactful design in this field that WEx can help people overcome. They are:

1. Our work happens in isolation.
2. We forget about the big picture.
3. Research, design and practice are disconnected.
4. Academic publishing is slow, expensive and restrictive.

Our site is intentionally designed to address these roadblocks. Next, we describe these challenges in more detail and how the WEx community can help you overcome these challenges.

Roadblock 1: Our Work Happens In Isolation

The first challenge we face is that our work often happens in isolation. We're hesitant or don't make time to share what we're doing or engage others in our process. We live in a world built on old traditions and incentives that encourage us to keep our work and ideas secret. We compete for funding and recognition through publications. We worry that our ideas might be stolen. It's also uncomfortable to share our work when it isn't polished or finished. Even if we get past those incentives, we aren't always sure how to share our ideas in meaningful ways.

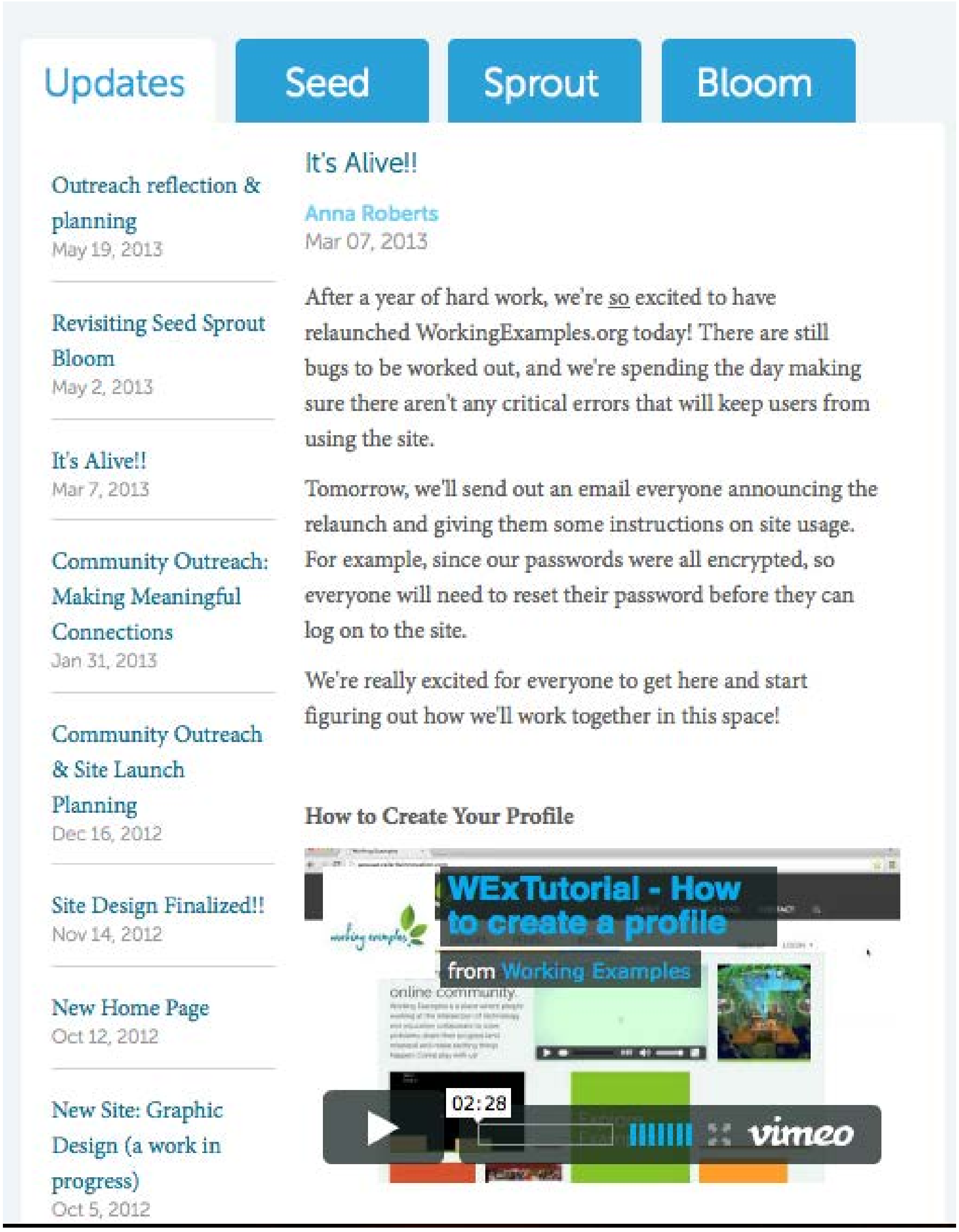

Figure 2: WEx Updates Section for Sharing Progress.

We get it; we have our own Example and struggle with how much to share, what's 'safe' to share, and finding time to work on our Example. But we also strongly believe that sharing your work and getting (and giving) feedback will help move the field forward and will result in better, more effective learning games. To make something truly innovative we need to share our work and engage other people in order to integrate their ideas.

WEx creates a community of practice and facilitates sharing our work while it's in-progress, so we aren't working in isolation. One way to engage people in the progress of your project is through an Example's updates, which work just like blog posts (See Figure 2). You can engage with the community by sharing what you're working on and how your idea is evolving, posting about major milestones, or asking when you need advice, feedback or expertise.

Roadblock 2: We Forget About The Big Picture

This roadblock is related to working in isolation, but it refers more to our process and how we relate our work to outside influences that might impact it. We often get bogged down with the details of our work and forget to consider the bigger picture. Whether you're doing research, designing a game or creating a curriculum, the success of your work can be affected by asking questions like:

- Is there applicable research I should take into consideration?
- What are the relevant industry or policy trends that will affect my work?
- Is there similar work happening already? And if so, how is my work different?
- Who do I want to be impacted by my work? What can I do to make sure it reaches them?

Beginning your process with this 'discovery' or research phase means that your work and decisions moving forward will be well-informed. Continuing to ask those questions throughout your process helps ensure that your work will reach its goals and its audience. If you're not asking these questions, how can you be sure that you're making something that will be new and something that people really need?

In WEx, the "phases" section of an Example helps you document your designs and iterations, but it also helps to keep you focused on the big picture. The questions in Seed, Sprout, and Bloom (see Figure 3) are derived from best practices from design and business to help you reflect on your process. All ideas start as seeds, continuing to develop as they sprout, grow, and eventually bloom into fully realized ideas and solutions. Seed helps you lay out your vision, the problem you're trying to solve and why it's important. Sprout has you describe how you're implementing your ideas and how they are evolving. And Bloom helps you reflect on your process, what you've learned, and your plan moving forward. All three phases help you to stay focused on the big picture, so you don't lose track of the "how" and "why" that are so important for creating designs and research that will positively impact learners.

Roadblock 3: Research, Design and Practice Are Disconnected

The third problem that WEx is designed to address is the disconnection between research, design and practice. Working with people in other disciplines is challenging. We have different ways of communicating and getting things done and unique vocabularies. It takes extra time and effort to coordinate cross-disciplinary collaborations. We also have to find people that can contribute to our projects, which means doing research and outreach to (most likely) strangers. As a result, we often don't make an effort to work with experts in other disciplines.

The WEx team has made a conscious effort to have a very multidisciplinary design process and it's amazing how we can get stuck on the littlest things. For example, our developer and director kept talking about 'development' and it was clear that even though they both thought they understood each other, they were totally missing the boat. It came down to defining what we meant by the word 'development' so we could understand each other and move forward.

WEx might not be able to help you directly with the messy personal stuff, but it can help you find people in other disciplines. Our community is made up of a huge cross section of this field—designers, researchers, educators and everything in between. You can browse or search people and Examples on the site to find the expertise you're looking for. There's also a recommendation engine that recommends people and projects that you might find interesting. The engine uses the tags that you put in your profile and your Examples to connect you with people who are doing work that might be interesting to you. The more active you are on the site, the better the recommendations will be. You can access the recommendation engine by browsing by "most recommended" or on the home page by clicking on the "stuff you'll like" button.

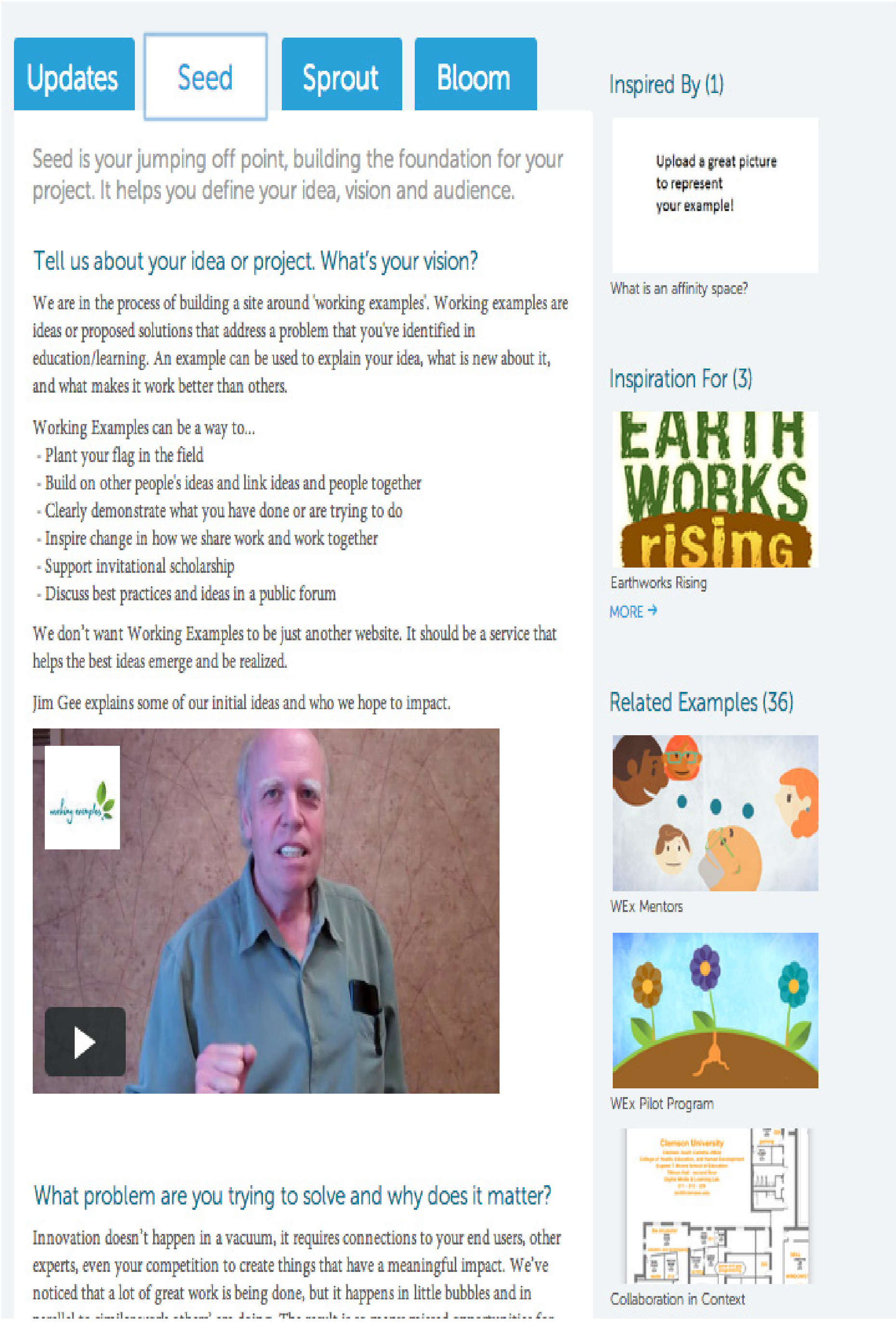

Figure 3: WEx Example Seed Section.

Roadblock 4: Academic Publishing Is Slow, Expensive and Restrictive

In addition, WEx attempts to address some of the challenges of academic publishing. Academic publishing is slow, inaccessible for non-academic audiences, biased toward the discussion of only successful results (discussion of failure is rare), and problematic for showing non-text-based work, such as video games (Jose, 2012; Nielsen, 2011); making important research difficult to apply to practice. Entire academic disciplines are turning to open access models to disseminate their work (Suber, 2012; arXiv.org, 2013).

WEx is an example of green open access: an open repository allowing you to show your work at any stage of development, to any degree that you are comfortable, and invite the larger community to collaborate as you wish. Through posting Examples and interacting on the site, we hope to collectively impact our world and shape the future of education and learning.

What WEx Can Do For You

WEx is an example of a solution to these four problems. It creates a diverse community of practice so you aren't working in isolation. It can help you think through process so you don't forget about the big picture. It allows us to learn from each other, so we can better connect research, practice and design. It's an open access platform that can serve as an alternative medium for sharing the important ideas we have and work we do.

But for all these things to happen we need *you* to engage and make this community what you want it to be. It won't work without you. *You* can change how we share our work and collaborate. Start by creating a profile. Be intentional, share your work, reflect on your process and start some conversations!

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Workshops

Analyzing Log File Data to Understand Players

Kristen DiCerbo, Pearson, kristen.dicerbo@pearson.com

Abstract: There is great interest in using games to assess players' knowledge, skills, and abilities. However, while games are capable of collecting information about micro-processes of players as they move through the environment, procedures for translating this information into inferences about player proficiencies are not well known. This workshop introduced participants to specific techniques for uncovering patterns in log file data. Techniques were introduced to uncover player groups, action clusters, and patterns of action that illuminate differences between players at different levels of constructs of interest.

Introduction

Digital environments allow us to capture large quantities of information about what students do as they interact with software and each other, seamlessly recorded as they go about their daily activity. These interactions can produce an "ocean" of data, which, if used correctly, can give us a completely different view of how students progress in acquiring knowledge, skills, and attributes (DiCerbo & Behrens, 2012). However, the potential of using this data to understand what students know and can do can be met only if methods for investigating stream or trace data can be developed in psychometrically and computationally feasible ways. Traditional psychometric models have commonly been focused on point-in-time models which overlook variation in activity over time (especially at the micro level). New interactive digital experiences such as on-line learning environments and games, however, elevate both the availability and importance of understanding student temporal micro-patterns which often reflect variation in strategy or evolving psychological states. While the richness of the data holds promise for making important inferences, standard methods for scoring and analysis do not exist. In sum, common practice has not kept up with changes in common data represented in detailed log files.

Evidence-Centered Design (ECD; Mislevy, Steinberg, & Almond, 2003) helps us link the activities from a game, to evidence gathered from those activities, back to the inferences we want to make about players' knowledge, skills, and abilities. ECD provides the language that lets us articulate the elements needed to gather evidence from game play. First, we need to identify the features of game play that we hypothesize will provide that evidence. Then, we need to determine scoring rules for this evidence. This can be correct/incorrect, present/not present, or a record of the number of seconds taken to complete a task, for example. These pieces of evidence then need to be combined to tell us about the latent, unobservable, constructs we are interested in. There are a variety of statistical methods (e.g., Item Response Theory, Bayesian Networks, Diagnostic Classification Models, and factor analysis) to accomplish this aggregation, depending on the types of data and desired inference.

While ECD helps us define the elements need to make claims about players, in many cases, we have rich log data but weak theory to guide rule formulation. Often, when we design new learning environments, we have some hypothesized models about how actions observed in the game relate to proficiencies, but they are largely a result of expert opinion and best guesses. Without information about what learners actually do in an environment, it is difficult to be confident that we have fully captured the elements of performance that are related to constructs of interest. These conditions suggest that exploratory analyses are needed to uncover these relationships.

Exploratory Data Analysis (EDA) is a conceptual framework aimed at providing insight into data as it is presented to the working researcher (regardless of its origin), and to encourage understanding probabilistic and non-probabilistic models in a way that guards against erroneous conclusions (Behrens, DiCerbo, Levy, & Yel, 2012). It serves to identify patterns and suggest plausible hypotheses to explain them. Using a variety of tools, it encourages the exploration of the patterns in data and the potential explanations for those patterns. Then, the most promising hypotheses can be extracted for further testing using more confirmatory methods.

The purpose of this workshop was to provide examples of projects that had used various methods to make inferences from log file data and introduce participants to tools through that they can use to begin to uncover patterns in log file data.

Review of Existing Projects

The first portion of the session provided examples using a variety of techniques summarized in Table 1.

Aspire - Efficiency	Poptropica – Persistence	SimCity – Information Use
Natural Language Processing – stemming and tagging	Univariate and Bivariate exploratory data analysis	Univariate and Bivariate exploratory data analysis
Identification of Indicators	Classification and Regression Tree	Clustering
Network Analysis	Confirmatory Factor Analysis	Network Analysis
Principal Components Analysis		

Table 1. Game Projects and Constructs with Analysis Techniques

The key take-away from this review was that projects require a range of statistical techniques. The more tools available to the analyst, the greater the flexibility in questions that can be explored and answered.

Getting to Know Data

Following the review of projects, participants were provided with a sample data set and code for analysis. These materials can be obtained from the author. Prior to performing any analyses, data must be cleaned and restructured from its raw form into a form that is suitable for analysis. This often involves selection of cases, examination of outliers, and aggregation of various forms. There are numerous tools available for such work, but some basic Microsoft Excel formulas were provided that accomplish many of these tasks.

The most basic element to examine in data is the distribution of variables. What is the distribution of the number of events that players' engage in during a session? What is the distribution of places visited? Simple histograms are a good place to start with these questions. One thing we usually find is a distribution with some very large outliers, particularly in data related to duration or time spent on activities. In most systems, if someone moves away, engages in another task for a few hours, and comes back, all that is recorded is that there is a 3 hours difference in the times. It is unlikely that someone actually spent three hours on this one event. However, we don't know this from the logs. As a result, we need to select what we think is a maximum reasonable time to complete a task and remove the outliers for most of our analyses regarding time. Participants will examine the distributions, make decisions about the inclusion of outliers, and create new datasets based on these decisions

Following the basic univariate analyses, the most common questions to explore are the relationships between variables. Scatterplot matrices help examine bivariate relationships across a set of variables. These visualizations are essential in combination with numerical correlation analysis for pattern detection as they give insight into the shape (linear, curvilinear, etc.) of the distributions and analysis of relationships between categorical variables.

Finding Groups in Data

One way to look for patterns in data is to examine whether there are groups of people who have similar play patterns or groups of actions that tend to occur together. This is a task for cluster analysis. While the use of clustering of quantitative measures has been well established since the 1930s (Behrens & Smith, 1996), applications of these techniques to categorical log data have only more recently been developed in the Statistical Natural Language Processing (SNLP) literature (Manning & Schuetze, 1999), text mining (Feldman & Sanger, 2007) document retrieval literature, and even the and network security intrusion detection literature (Marchette, 2001). Participants were provided with R code for running hierarchical cluster analysis, including the creation of dendrograms (see Figure 2). However, caution was urged because even the few lines of code required contained a number of assumptions about the algorithms used to compute the clusters. Users should familiarize themselves with the possible choices and implications for the options available.

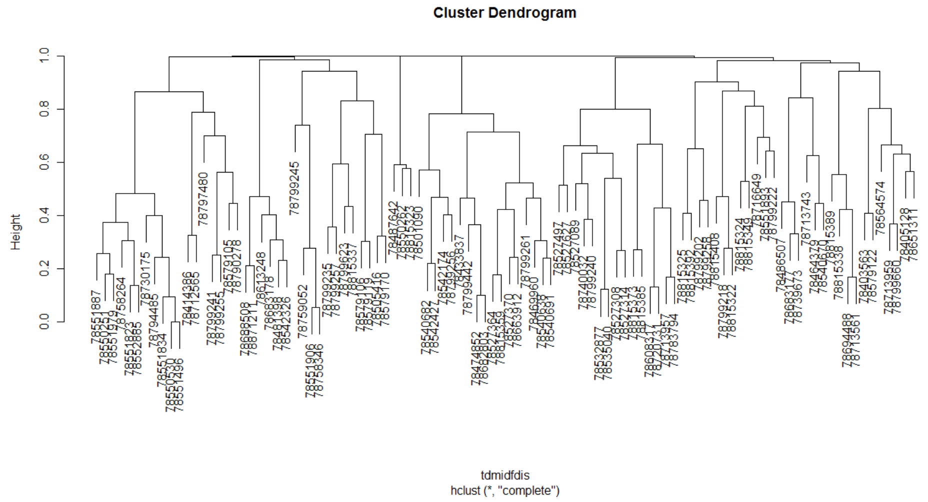

Figure 2: Dendrogram from Hierarchical Cluster Analysis of Users

Analysis of the variables by which players are clustered can reveal the types of measures which may be helpful in differentiating among players at different levels on constructs of interest. For example, we might find clusters of players grouped by time spent on difficult tasks and number of tries after failure that indicate persistence. Similarly, we might find groups based on number of times repeating a challenge and repetition toward optimal solutions that we would hypothesize indicate perfectionism.

Analyzing Sequences of Action

We are often interested in the sequences of actions that players take within a game and there are a number of ways we can analyze these sequences. First, the relatively simple process of creating n-grams, or groups of 2, 3, or n actions to examine the frequencies of the most common sequences of actions will be introduced and undertaken by the participants. Analysis of differences in these frequencies, particularly among groups known to be different on a characteristic of interest, can lead to hypotheses about differences in game play process.

Second, participants will be introduced to the use of sociograms from the tradition of network analysis. The practice of creating sociograms has been used, for example, by teachers in classrooms (Fueyo, & Koorland, 1997), to describe networks of drug users (Pivnick, 1996), and by developmental psychologists (Rodkin, Farmer, Pearl, & Van Acker, 2000). In typical applications, the elements are individuals; people are represented as nodes in the sociogram and links between them as edges. The key to using these techniques in log file analysis is to extend these concepts to thinking of actions as “neighbors” in the network. Each “move” in a log file is more or less connected to other moves, depending on when and how often it is made, as seen in the text mining literature (Feldman & Sanger, 2007). Figure 3 presents sociograms from two players who received the same score in a game. Examination reveals that the paths they took were clearly different. These exploratory analyses can yield important information about how processes of game play can differ even when the final result is similar. In this example, information about how often players switched from one location to another and back, along with their number of total moves, became the basis for a measure of efficiency of solutions.

One of the interesting aspects of sociograms is that social network analysts have developed a series of quantitative measures to describe the relationships seen in the visualization. These include measures of how connected the network is (density), how central an individual is to the network (centrality), and numbers of connections through an individual (degree). These standard metrics of social network analysis may be “translated” to make inferences about the elements of a log file.

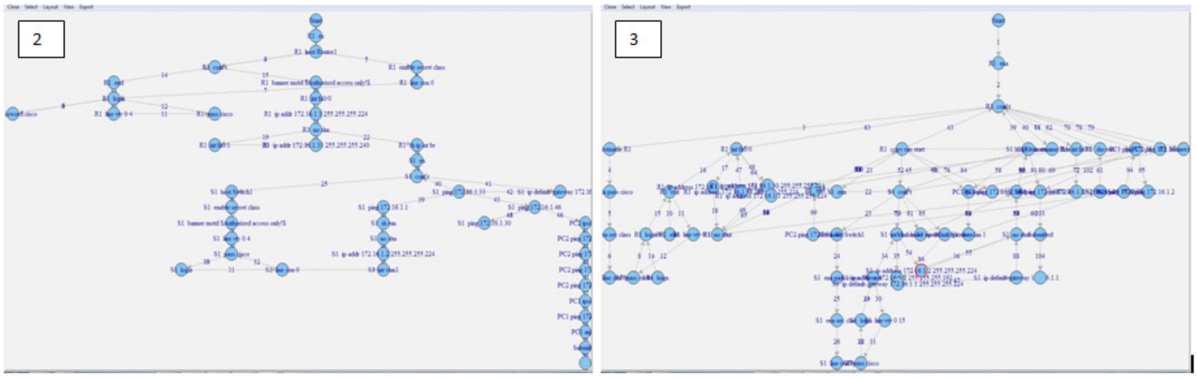

Figure 3: Two sociograms of actions from players who earned the same score

Conclusion

Making inferences from players based on their in-game actions requires the use of a variety of statistical tools and methods, often used in combination. While a brief workshop does not provide sufficient time to introduce, much less master them, the purpose here was to introduce various techniques and provide examples of their application. The work generally requires a frame of exploratory data analysis as hypotheses are rarely developed enough to be explicitly tested in early phases. Tukey (1969) used the analogy of detective work to describe the iterative process of generating hypotheses and looking for fit between facts and the tentative theory or theories, modifying theory and generating new hypotheses. It is important that an emphasis on statistical tools not overshadow the larger meaning-making in this endeavor.

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Designing and Researching Games to Reduce Stereotypes and Biases: A Psychological Approach

Mary Flanagan, Geoff Kaufman, Cote Theriault, Tiltfactor Laboratory, Dartmouth College
mary.flanagan@dartmouth.edu, geoff.kaufman@dartmouth.edu, cote.a.theriault.13@dartmouth.edu

Abstract: The workshop gave audience members a first-hand perspective on the psychological approach employed by Tiltfactor Laboratory to create and study games to reduce stereotypes and social biases. Participants played *Buffalo* and *Awkward Moment*, two card games created by Tiltfactor as part of a National Science Foundation-funded project addressing gender stereotypes in science, technology, engineering, and math (STEM), and completed sample post-game assessment materials used in recent experimental studies. Following game play, the presenters facilitated a thorough debriefing to explain the psychological foundation of the games' designs, the means by which the games combat stereotypes and bias, and the preliminary results from completed research involving both games. The session closed with a general discussion centering on the challenges and rewards of conducting rigorous, controlled research to test the efficacy of games, as well as the value of utilizing a cross-disciplinary approach to game design and research.

Introduction

Tiltfactor Laboratory (http://www.tiltfactor.org) is a design studio dedicated to creating games for social change. We design, study, and launch games, across a variety of digital and non-digital platforms, that use psychological principles to promote learning and fundamental human values. Our team investigates topics such as perspective-taking, empathy, and motivation, to create profound experiences that make a difference in people's lives. To illustrate, we are currently producing games that aim to combat biases and stereotypes against women in science, technology, engineering, and math (STEM) domains; facilitate open-source metadata gathering for public institutions; encourage altruism and prosocial behavior via social networks; and inspire new ways of thinking about public health and health care delivery.

We employ a psychological approach in our iterative game design process and in both the informal testing and formal assessment of our games. We rely primarily on systematic *experimental* studies (incorporating both quantitative and qualitative research methods) to test the efficacy of a game at achieving its intended cognitive, affective, or behavioral outcomes as well as to investigate broader questions about the phenomenological experience and subsequent psychological impact of games and play.

This workshop provided audience members a first-hand perspective on Tiltfactor's design and research process, particularly the team's efforts to create games to reduce stereotypes and biases. Our work takes it place alongside recent initiatives in the GLS community, in games such as *Fair Play* (Paiz-Ramirez et al., 2012; see also Devane & Squire, 2008), that have examined the impact of pervasive biases and stereotypes on learning and performance.

What are best practices in game design to combat bias? How can researchers select and implement reliable measures to assess a game's impact? How can designers ensure their games can be both fun and impactful? How can we understand the impact of social biases on learning and social interactions? To broach these questions and spark a meaningful dialogue, the workshop focused on the design and research processes for the Tiltfactor games *Buffalo* and *Awkward Moment* (Flanagan, 2012). Created as part of a National Science Foundation-funded project, entitled "Transforming STEM for Women and Girls: Reworking Stereotypes and Bias," both games employ mechanics and content that were informed by psychological theories on stereotypes and social cognition.

Background

The need for greater representation of women and people of lower socioeconomic status in STEM courses, majors, and careers in the United States is indisputable. Although women constitute 46.5% of the US workforce, they hold only 25% of all math/computer science jobs and 14% of engineering jobs (U.S. Department of Labor, 2013). The numbers for people of color and those from lower socioeconomic groups are similarly sobering; for example, according to recent statistics, African Americans and Hispanics held only 6.2% and 5.3% of all STEM occupations respectively (Babeo & Ellis, 2007; see also Ingels et al., 2011). Social and psychological factors, particularly the prevalence of negative stereotypes toward underrepresented group members' abilities in STEM, have been cited as the central causes of this imbalanced participation in STEM careers (see Hill, Corbett, & St. Rose, 2010 for a review). The perpetuation of these stereotypes creates a set of motivational barriers that explain – and perpetuate – this imbalanced level of participation in STEM fields. Among the most destructive of these barriers are under-represented groups' experience of *stereotype threat* and the formation of *implicit (i.e., unconscious) bias* against STEM. Combating these powerful psychological obstacles is central to shifting societal attitudes, beliefs, and behaviors in order to open up STEM learning for all.

Stereotype Threat

Stereotype threat describes the anxiety or concern that arises in a situation in which a person has the potential to confirm a negative stereotype about his/her group: this anxiety can profoundly disrupt the performance of an individual who identifies with that group or domain (Steele & Aronson, 1995). Specifically, stereotype threat activates physiological stress responses, encourages excessive performance monitoring, and instigates the attempt to mentally suppress thoughts of self-doubt, all of which deplete cognitive resources during a task or performance (Schmader, Johns, & Forbes, 2008). Likewise, the experience of threat may hinder individuals' flexibility in problem-solving (Carr & Steele, 2009), and activate failure-avoidance goals and worry (Brodish & Devine, 2009).

At the same time, research has revealed many effective means of reducing stereotype threat and counteracting its negative effects on performance and persistence, such as:

- Actively negating or dismissing an activated stereotype (Kawakami et al., 2000)
- Affirming a positive aspect of one's identity to counteract the activation of a negative stereotype (Logel et al., 2009; Martens et al., 2006; Rydell, McConnell, & Beilock 2009)
- Reframing a stereotype-relevant task as a challenge rather than a threat and emphasizing how the task can be an enjoyable way to gain knowledge or build skills rather than how it can be a way for individuals to show their inherent talent or ability (Alter et al., 2010)
- Adopting a *growth mindset* to anticipate improvement in a particular domain through persistence and practice (Aronson, Fried, & Good, 2002)

Implicit Bias

Implicit bias describes an unconscious and automatic negative association that is incorporated in one's mental representation of a particular social group or domain as a result of the prevalence of stereotypes in the social environment (Greenwald & Banaji, 1995; Greenwald & Farnham, 2000). In STEM domains, for example, girls and women may harbor a strong implicit association between "math" and "negative" or a stronger implicit association between "math" and "male" than between "math" and "female," even if they are not consciously aware of such representations and, moreover, even if they have a positive attitude toward math at the explicit level (Nosek, Banaji, & Greenwald, 2002).

Combating implicit bias requires targeting the automatic association and either changing it (e.g., retraining the mind and "automatizing" a new association through repetition) or making people aware of the often unrecognized impact that implicit bias can have on their perceptions, judgments, interpretations, attitudes, and behaviors. Among the most successful techniques for reducing implicit bias that have been validated by empirical investigation include:

- Exposing individuals to positive role models from a stereotyped group (e.g., successful female mathematicians or scientists: Blair, Ma, & Lenton, 2001; Stout, Dasgupta, Hunsinger, & McManus, 2011)
- Repeatedly negating an activated stereotype (Kawakami et al., 2000) or reinforcing one's goals to be egalitarian in one's views of social groups (Moskowitz & Li, 2011)

Workshop Overview

After a brief introduction, we conducted an informal simulation of the experimental procedures we previously employed in research on *Buffalo* and *Awkward Moment*, both of which aim to address the psychological obstacles of stereotype threat and implicit bias in the context of a fun, immersive party game experience. Participants played the games with five to seven other audience members and also completed individual assessment items on a paper-and-pencil questionnaire for each game. After both game play and assessment cycles, we led an interactive debriefing session, during which we shared more information about the design of the games, the means by which they aim to decrease stereotypes and biases, and the preliminary results from recently completed research. The session closed with a general discussion of the challenges and rewards – and we argue, the *necessity* – of conducting rigorous, controlled research to test the effects (and effectiveness) of games, as well as the value of utilizing a cross-disciplinary approach to game design and research.

Phase 1: Game Play and Assessment (30 minutes)

To begin the workshop, audience members played *Buffalo* and *Awkward Moment* and completed a sample of the assessment items used in recent Tiltfactor research on both games. To simulate the experimental conditions used in this research, groups of participants were assigned to play either "bias-relevant" versions of the games (with content addressing occurrences of bias, particularly gender bias in STEM) or "neutral" versions (whose content did not address bias). The assessment items, which were administered in paper-and-pencil questionnaires, consisted of both previously validated psychological measures of stereotypes and biases as well as original measures created by Tiltfactor team.

Game Descriptions

Buffalo. In *Buffalo*, a game designed for teenagers and adults, players simultaneously flip cards from two decks. One deck contains cards that list adjectives on them, including ones based on age (e.g., *young, old*), race (e.g., *Hispanic*, *Caucasian*, *multiracial*), physicality (e.g., *tall*, *unattractive*, *blond*), personality (e.g., *strong*, *corrupt*, *funny*), and ideology (e.g., *spiritual, eco-friendly*). The other deck contains cards listing nouns, including ones based on profession (e.g., *scientist*, *supermodel*, *talk show host*), role (e.g., *grandparent*, *superhero*), and organizational affiliation (e.g., *environmentalist*, *feminist*). Using the noun-adjective combination formed by the cards drawn, players race to collect the cards by identifying a real-life person or fictional character whose identity satisfies both words shown (see Figure 1).

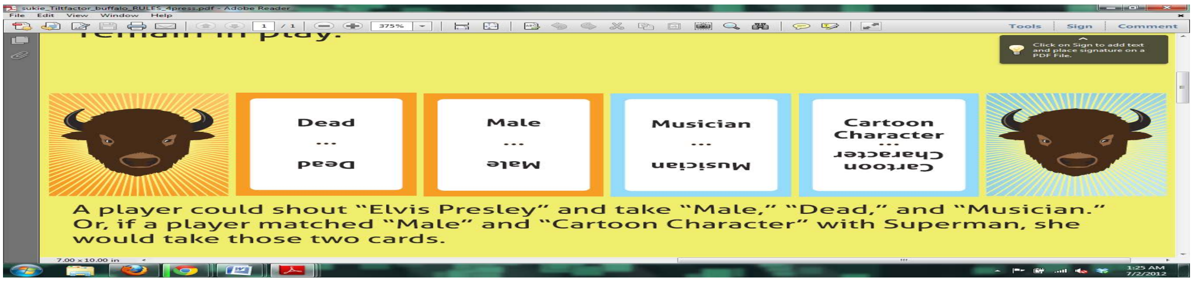

Figure 1: Sample adjective cards and noun cards from *Buffalo*. With the cards displayed, a player could win the "Male" and "Musician" cards by shouting out, "Justin Bieber."

The game activates a plethora of cross-cutting identities, some of which may fit with stereotypes and are thus easier to come up with (e.g., a "*male scientist*" or "*greedy CEO*"), whereas others may defy players' preconceptions of a category and thus be more difficult to name (e.g., a "*female scientist*" or "*saintly CEO*"). By exposing players to descriptor combinations that may or may not be consistent with common stereotypes, the game can facilitate sophisticated thought and discussion about the ways that individuals' perceptions can be influenced by prior associations and expectations.

Awkward Moment. In *Awkward Moment*, a game designed for middle school students, players begin with a hand of five "Reaction Cards" (see Figure 2); these cards describe potential responses to the game's "awkward moments," including actions (e.g., "Scream your head off," "Write a blog post about it," "Talk it out"), exclamations (e.g., "Rats!" "OMG," "No way!"), and frames of mind (e.g., "Get serious," "Relax," "Channel your inner warrior"). During each round, one player serves as the "Decider" and draws a "Moment Card" (see Figure 2) that poses a hypothetical situation (e.g., "Somebody hacks your Facebook account and changes your status to 'Girls are stupid.'"). The other players then respond to the drawn Moment Card by submitting a Reaction Card from their hands face-down to the Decider. The Decider then reads each of the submitted cards and selects a winner for the round. The game aims to stimulate thought and discussion about responses to social and academic dilemmas, particularly situations that involve bias against girls and women in STEM. Many of the cards in the Moment deck present situations in which a female is a target of stereotypes. In some situations, players imagine *being* a target themselves.

Figure 2: Sample Reaction Cards (top) and Moment Card (bottom) from *Awkward Moment*.

Assessment Measures

After playing *Awkward Moment*, participants completed two key measures: (1) a Tiltfactor-devised instrument assessing gender bias in STEM that presented respondents with a set of photographs of six individuals (3 female, 3 male), identified as new game characters, and asked them to assign a list of occupations (including *scientist*) to them and (2) a validated measure of perspective-taking assessing respondents' adoption of an other-oriented point-of-view, including the task of drawing a capital letter E on one's forehead (the orientation of which indicates either a self-directed or other-directed vantage point: see Galinsky et al., 2006; Hass, 1984). Likewise, following *Buffalo* game play, participants completed previously validated scales measuring respondents' level of *universal orientation*, a psychological construct corresponding to general non-prejudice (Phillips & Ziller, 1997) and *motivation to avoid prejudice*, the desire to recognize and control bias in one's own judgments and actions (Plant & Devine, 1998).

Phase 2: Debriefing (15 minutes)

Following the game play and assessment period, we provided an overview of Tiltfactor's efforts to create and study games for social change explained the psychological principles and theories that informed the design of both *Buffalo* and *Awkward Moment*, including the key concepts of stereotype threat and implicit bias. In addition, we discussed the means by which the assessment items aim to measure respondents' levels of stereotypes and bias. Finally, we presented the preliminary results from recently conducted studies that revealed that: (1) *Buffalo* significantly increased participants' perceptions of the diversity of their self-identified social ingroups and decreased category-based social judgments; (2) *Awkward Moment* significantly increased players' association between "female" and "scientist" and inspired greater assertiveness in response to hypothetical occurrences of bias; and (3) framing the games explicitly as ones dealing with social stereotypes (versus framing the games as ones dealing with social *situations* or *knowledge*) reduced players' enjoyment and limited the games' effectiveness as tools to reduce bias.

Phase 3: General Discussion (15 minutes)

The session closed with an interactive discussion/question-and-answer period, focusing on the challenges and rewards of taking a psychological approach to game design and research. We presented a number of games that have aimed to tackle stereotyped and bias and invited audience members to share their own game designs and research experiences, insights, and approaches. We offered insights from our lab's design work and research that have revealed that games that aim to tackle a stereotype-relevant task or domain – in particular, spatial reasoning skills among female players – can actually backfire and *increase* stereotype threat if the game is not designed in an approachable and accessible way to scaffold learning appropriately – or if the game itself is explicitly framed as one that is relevant to spatial performance, Next, we discussed the importance of developing and deploying appropriate cross-disciplinary research methods to test the efficacy of games for achieving their desired impacts.

The final section of the discussion centered on the importance of recognizing the potential for bias to emerge in games and play contexts, and the need for designers and researchers to be mindful of games' content, mechanic, and frame, as well as the way games are perceived and experienced by diverse player groups. The disc

About the Presenters

Dr. Mary Flanagan, founding director of Tiltfactor, is a scholar and researcher focused on how people create and use technology. Her explorations across the arts, humanities, and sciences emphasize the use of methods and tools that bind research with introspective cultural production. She is particularly interested in exploring issues of equity and authorship in technological environments and reworking commonly understood paradigms to provide collective strategies for social change. In 2003, Flanagan created Tiltfactor as a rigorous theory/practice laboratory devoted to the investigation and creation of games and play. Flanagan has written more than 20 critical essays and chapters on games, empathy, gender and digital representation, art and technology, and responsible design. Her three books in English include the recent *Critical Play* (2009) with MIT Press. As an artist, her internationally exhibited work ranges from game-inspired systems to computer viruses, embodied interfaces to interactive texts. She is the Sherman Fairchild Distinguished Professor in Digital Humanities at Dartmouth College. **http://www.maryflanagan.com**

Dr. Geoff Kaufman is a postdoctoral researcher in psychology at Tiltfactor and the inaugural scholar-in-residence at Dartmouth College's Office of Pluralism and Leadership. He holds a Ph.D. and M.A. in psychology from Ohio State University, and a B.A. in psychology from Carnegie Mellon University. His research focuses on how *experience-taking* – the mental simulation of characters' experiences in fictional narratives, virtual worlds, or games – can change individuals' self-concepts, attitudes, behaviors, and emotions (Kaufman & Libby, 2012). He has investigated how such experiences can build interpersonal understanding and empathy, reduce stereotypes and prejudice, and inspire higher levels of social consciousness.

Cote Theriault is a former research assistant at Tiltfactor and a M.A. candidate in the Applied Developmental and Educational Psychology program at the Lynch School of Education at Boston College. She earned a B.A. in psychology with a minor in human development and education from Dartmouth College in June 2013. At Dartmouth, her research focused on the impact of framing on game play and cognitive performance related to Science, Technology, Engineering, and Mathematics (STEM). Her current research interests include the ways in which various features of board games facilitate the math development of young children.

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Designing and Building Mobile, Locative Games with ARIS

Garrett W. Smith, John G. Martin, David J. Gagnon, Breanne K. Litts, University of Wisconsin - Madison, Owen Gottlieb, New York University
gwsmith@wisc.edu, johnmartin@wisc.edu, djagnon@wisc.edu, litts@wisc.edu, owen@converjent.org

Abstract: This proposed workshop will introduce participants to ARIS, a platform that allows non-programmers to create their own mobile, locative augmented reality games and activities. Through demonstration, hands-on participation, and reflective discussion, participants in this one-hour workshop will leave with: 1) connections between situated learning, mobile technologies, place, design, and games, 2) possibilities of using augmented reality games to create new learning opportunities with mobile devices, and 3) their own sample ARIS game that includes both narrative and data-gathering elements. This proposal discusses the ARIS platform and its theoretical foundations as well as the goals and activities of this ARIS workshop.

Introduction

The ubiquity of smartphones poses challenges for classroom management, but more importantly, opportunities to create deep learning experiences in new ways. We developed ARIS as a practical way for non-programmers to use mobile devices to bring together ideas from situated learning, games, place-based learning and design-based learning to do just that. Over the last three years, a wide variety of people have taken up this challenge, producing diverse curricula and games, and we want to keep bringing new groups into this exciting world of place-based mobile game design. In the proposed workshop, we will play through an example ARIS game that includes a light narrative line and data-gathering component. We'll step through the design of a simple game using ARIS (arisgames.org), a drag-and-drop browser-based game platform. Bring a laptop for hands-on design, an iOS device to play. Or just come to discuss what a future of experiential education may be like.

Through demonstration, hands-on participation, and reflective discussion, participants will leave with: 1) connections between situated learning, mobile technologies, place, design, and games, 2) possibilities of using augmented reality (AR) games to create new learning opportunities with mobile devices, and 3) their own designed ARIS game that includes both narrative and data-gathering elements.

Theoretical Framework

The design of ARIS has been heavily influenced by theories of situated learning (Brown, Collins, and Duguid, 1989; Lave and Wenger 1991), games and learning (Gee, 2003 ; Squire, 2006) and place-based learning (Gruenewald, 2003; Ellsworth, 2005).

Mobile technologies have showed promise in shaping how we think about learning and the design of learning environments (Squire, 2009; Squire & Dikkers, 2011). Educational researchers have examined a number of transformative uses of mobile technology, and one of the most promising is augmented reality (e.g. Squire & Klopfer, 2007), where virtual data or representations are coupled with real world locations and contexts. In this early research, a number of scholars probed how location-aware mobile devices may be used to engage a unique form of educational video games (Klopfer, 2008). This line of research has not only developed ideas for how to create more meaningful educational experiences, but also made progress toward understanding how mobile technologies make other pedagogical advances practically possible; for example, problem-based (Barron et al., 1998) and place-based learning have proven difficult to instantiate within traditional classroom settings, but show promise through mobile technologies. Specifically, a variety of mobile learning designs, such as environment simulation (Klopfer & Squire, 2008), design literacy (Mathews, 2010), and scientific literacy and argumentation (Squire & Jan, 2007), have demonstrated favorable results.

Yet, like a lot of inspiring educational research in this area, this innovative academic research was somewhat limited in scope and has spread far more slowly than the vast cultural changes brought about by modern technologies. To understand what new, undiscovered capabilities mobile offers for teaching and learning requires broad experimentation around the basic functionality of mobile devices.

Therefore, we joined the effort to create software and pedagogy that has the capacity to have a transformative effect and is capable of scaling in new ways. In the case of mobile learning, we need a way for the masses to begin exploring the educational affordances of using mobile technology to restructure our relationship with place. Additionally, we believe that mobile technology has inherent technological affordances and ecologies of use that are capable of generating new types of learning environments and interactions worth exploring.

By using these ideas to design an accessible mobile augmented reality platform, ARIS, we have opened the world of mobile learning experimentation and design to a diverse audience, allowing students, artists, classroom teachers, and educational researchers to participate in the creation of new worlds at our fingertips.

ARIS Platform

ARIS is an easy-to-use, open-source development platform that allows anyone to create locative mobile games and activities for formal and informal learning environments. Locative virtual tours, interactive cases, situated documentaries, or data collection activities can be authored in a browser-based drag-and-drop editor, then "played" on iOS devices. We expect that anyone interested in mobile learning, locative meaningful play, or designing narrative- or data collection-based activities will find this workshop relevant.

Open Source

In addition to being a useful tool, ARIS also exemplifies how an open-source model can be used to cultivate, scale and sustain educational innovation at large. In addition to using open-source licensing, the ARIS project is built around an ethos of easy entry, collaboration and distributed participation. Because the ARIS platform is designed for non-programmers, it allows a wide-range of users to quickly and easily build their own mobile-based learning activities and experiments. The resulting community of users, which currently includes over 4,800 authors and 10,000 unique designs, continues to grow and cross-pollinate, especially as more domains and research perspectives are being represented. In addition to sparking the development of new ARIS features and functionality, this diverse user group has collaborated to develop new methods of enacting and researching mobile-based learning.

Our main goal with ARIS is to mainstream experimentation with the creation and play of mobile augmented reality games and activities, largely across a variety of learning contexts from classrooms to museums to the great outdoors. So, we want the authoring tool to be as easy to use as possible by teachers, students, and researchers alike. We want the client, by leveraging the device's ability to connect to and make sense of the outside world, to provide a powerful and transparent means of interacting with these game worlds. Finally, ARIS is not intended to be a finished product, but something that grows out of communication surrounding its own use. Accordingly, we want ARIS to expand and deepen the repository of viable mobile learning experiences by drawing from growing bank of use cases to steer its growth, development, and our own understanding of how mobile technologies and augmented reality can be used to achieve learning goals.

ARIS itself is very much a product of the iterative process of design-based research (Brown, 1992; Design Based Research Collective, 2003). We've specifically designed ARIS as a prototyping tool by offering users a simple on-ramp to quickly design games and activities and get them working in a rough form. Not only does this jump start the iterative design process, but it also allows for early playtesting, so that something can be learned from real-world use. Novice authors can get a simple narrative-based game playable in less than an hour and a data collection style activity for even as fast as one minute for a data collection style activity.

Partly, we have been interested in this because we really enjoy making augmented reality games and want to share that joy as broadly as possible. But this project is also motivated by several converging threads of educational thought and research, many questions whose answers seem to lie within enabling large-scale, grass roots experimentation with the creation and play of mobile augmented reality games.

Features

The ARIS platform consists of a web-based editor (see Figure 1) for authoring games, an iOS client app (see Figure 2) for players to interact with games, and a server (LAMP) running in a cloud-based environment with which both the editor and iOS client communicate. In this sense, ARIS games are "server-based", not requiring additional actions to become published.

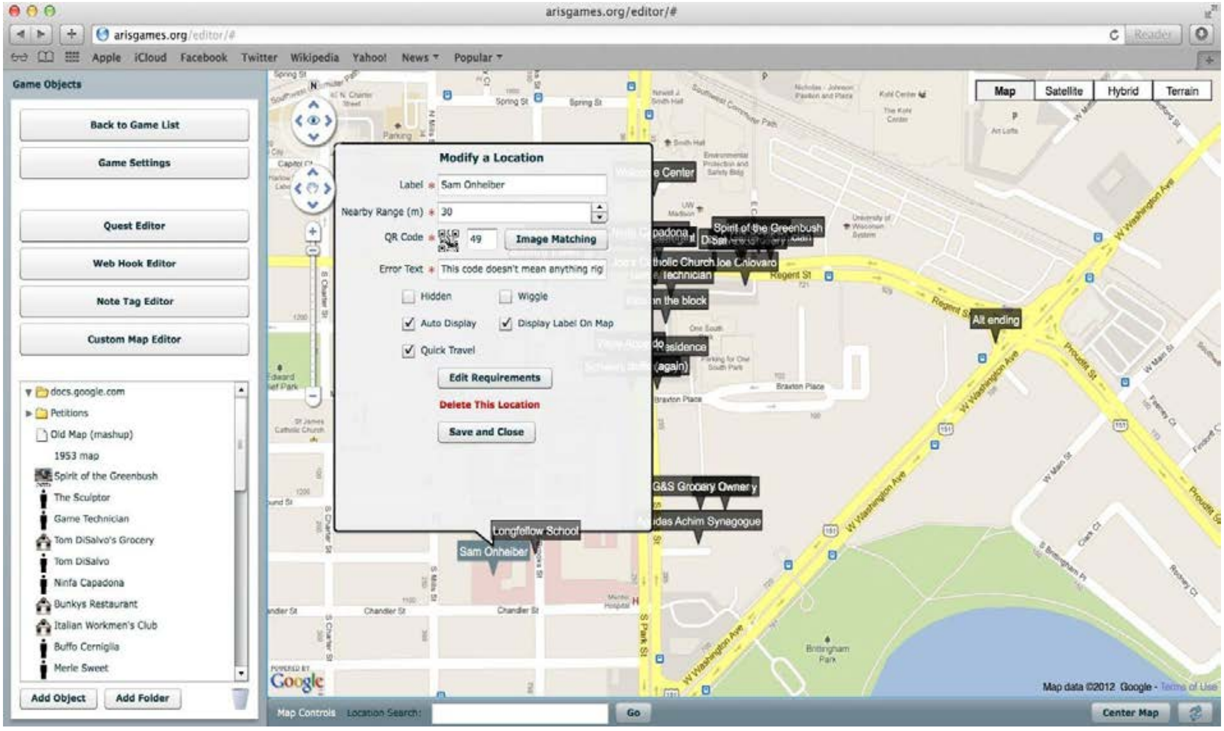

Figure 1. ARIS web-based editor in which authors create games.

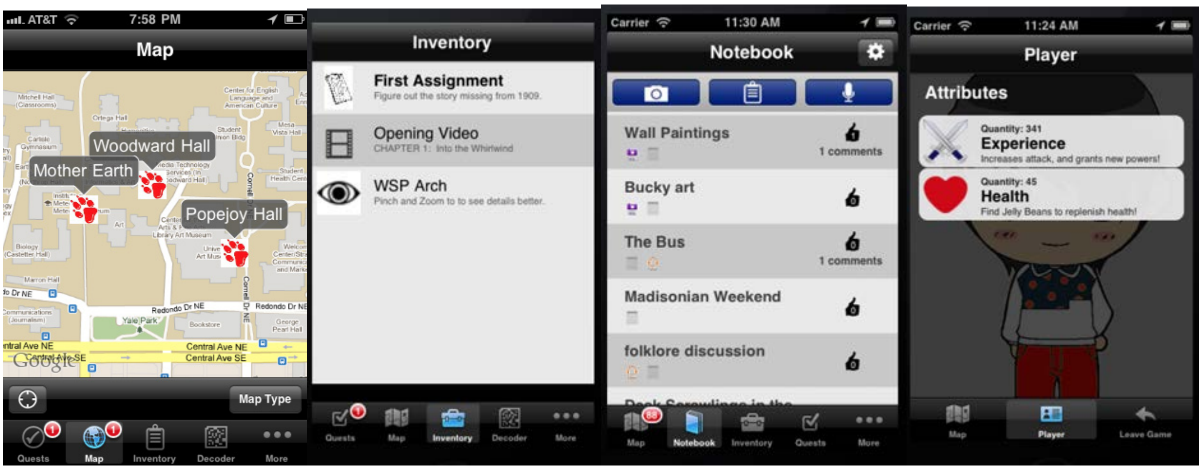

Figure 2. ARIS iOS client application Map View, Inventory View, Notebook View and Player Profile View.

The client provides players with access to play any games that have been authored by anyone using the editor. Players can look for games near their current location, by popularity, or by title search.

The main interface of the client is organized by several tabs. *Quests* is used to give the player contextual information about what they have done and what they can do next, the *map* displays a player's location, a rendered map, and the locations of game objects. Other tabs include a *decoder* (QR codes, bar codes, manual entry), player *inventory*, player *attributes*, and the *notebook*.

The player navigates through game play either using the *map*, *decoder* or a combination of the two. Most commonly, the map is used for outdoor games, while the decoder is used for indoor games. When the map is used, game objects will appear on the map according to the requirements set by the author of the game. When the decoder is used, the game objects are displayed in the actual environment as a QR code for players to scan and, similarly, their interaction is based on the requirements set by the author of the game. Furthermore, as part of gameplay, players unlock new *quests* that give them goals to complete in the game. Quests often include visiting certain characters in the game or adding specific items to the player's inventory, but can be much more complex.

In an ARIS activity, the game space consists of virtual objects overlaid onto real-world places and spaces. There are several different types of virtual object possible. *Plaques* are the simplest ARIS objects; they are pieces of information (text and media) located in space. Simple virtual tours are made by simply creating a few plaques and placing them appropriately in the world. *Items* are objects that ARIS players can pick up and take with them. Items can be picked up off the map, given to a player by characters in the game, and created by the player. The *player's inventory* displays all the items the player currently has. Likewise, the player can also be given attributes in the game, such as health, experience, etc, which is logged in the *player's attributes*. Finally, characters afford virtual dialogue with players via a "hub-and-spoke" method similar to that used in games like Mass Effect. Characters can also interact with player's inventories in these bits of dialogue, giving them items or attributes, or taking them away.

All of the plaques, characters, and items in ARIS games can be linked to real world locations; players can access them by being within a specified distance of a location (detected through GPS) or by scanning a QR code with the decoder. Game designers can also enable "quick travel" mode for any object, which overrides the location-specific requirements of that object, so that the player can interact with it from afar.

In addition to these core objects (plaques, characters and items), there are several features that allow for more complex games. First, the fact that ARIS is server-based allows games to become multiplayer virtual worlds, where interactions by one player in the game can affect other players. For example, items can be limited in number, where one player picking up an item may make it unavailable to another player. Players can also trade items with each other, allowing for the creation of virtual economies.

The *notebook* feature takes the idea of a shared virtual world in another direction. It allows players to create and share video, photo, audio and text content with other players of the same game. It is used to create data collection activities where the emphasis is on players' interactions based on what they discover and document in the world rather than what has been created for them by the author.

There are also features that allow for further variety in design using these basic objects. Rather than objects being placed individually at locations, authors can create items or characters that *spawn*, appearing within a specified radius of a player or given location at a specified rate. In this way, authors can create games where players' options are determined algorithmically. Authors also have the ability to create their own *custom maps* that appear or change during the game, overlaying Apple's iOS maps. This allows fictional or informational backdrops to the designed game world to be created and even to change in response to player actions. In a similar vein, *panoramic views* that overlay custom digital information onto the physical space when looking through the camera afford camera-based augmented reality without requiring the authors to have much technical skill.

Finally, authors can create HTML5-based web applications and place them at a location within the game, like any other object. With this feature, authors are not limited to creating game content via the ARIS editor. With a bit of programming skills, authors can design any web-based content and embed it into the game directly. This includes mini-games, simulations and even programs that manipulate the way ARIS functions. Not only does this allow for authors to create any kind of interactive content, it also affords the possibility for custom, high-end game production using ARIS as the base.

Workshop

This proposed workshop will introduce participants to ARIS, discussing what can be done with the platform and the kinds of games and activities that are typically built. The workshop will be hands-on, where participants see a situated documentary ARIS game, then spend the bulk of the workshop creating their own mobile, locative game. Participants will need to bring a laptop for hands-on design and an iOS device to play their games.

Goals

Through demonstration, hands-on participation, and reflective discussion, participants will leave with: 1) connections between situated learning, mobile technologies, place, design, and games, 2) first hand experience of some possibilities of using augmented reality (AR) games to create new learning opportunities with mobile devices, and 3) their own designed ARIS game that includes both narrative and data-gathering elements.

As typical in a design activity, we harness collaboration and peer-to-peer mentorship. About 90% of this session is dedicated to hands-on experience using ARIS, thus participants will be guided through a design process. ARIS is a user-friendly platform and community; often participants with more experience with technology begin to help those who may shy away from it, so that by the end of the workshop all participants increase in understanding the process both as teachers and learners.

Significance

At GLS 5.0 in 2009, the ARIS authoring tool was first revealed, allowing anyone to design and build their own augmented reality games. By the time of this workshop for GLS 9.0, version 2 of the ARIS editor will be we'll underway and the workshop will be able preview what is in store. The new authoring tool will be a full re-design, allowing designers to more efficiently build their designs. It will move from Flash to HTML5, allowing game authors to design on tablets as well as desktop and laptop computers. It will also incorporate new features, like a visual timeline-based quest editor and the ability to create custom maps. Finally, in conjunction with the new authoring tool, we are developing a new process for designing games in ARIS, including supports for developing storyboards and designing interactions with characters. With the new authoring tool, new design process and new features, GLS 9.0 is an ideal time for an ARIS workshop both for participants new to the ARIS platform as well as to existing users.

Activities and Timeline

This hands-on workshop will focus on creating a narrative-driven data collection-based activity with mobile devices. During this session we will give a brief overview of the ARIS platform, playing through a brief game and show how that game is built. Then, during the remainder of the two hour workshop, participants will build an ARIS project that employs two learning activities: 1) a narrative-driven tour, and a data collection-based activity (inquiry-driven field research). As a result, participants will gain a foundational and practical understanding of how ARIS can be used to design and implement meaningful activities in a variety of contexts.
Timeline:

- 15-minutes: Introduce ARIS
- 45-minutes: Participants (in small groups) are led through the steps to create the components of a situated documentary in ARIS.

ARIS has been used in a variety of formal and informal learning environments and content areas, including science, folklore, art, second language, physical education and history. This platform harnesses place to play a meaningful role in learning, whether it be to produce curricula or as a design/prototyping tool for students. Participants will leave the workshop both with a technical understanding of ARIS, and with an inspiration to push the boundaries of learning through mobile locative activities.

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Designing for Productive Failure

Cathy Tran, University of California, Irvine, University of Oslo, Norway, ctran27@gmail.com
Blair Lehman, University of Memphis, blair.lehman@gmail.com
David Dockterman, Scholastic Inc., ddockterman@scholastic.com
Jesper Juul, New York University, j@jesperjuul.net
Sidney D'Mello, University of Notre Dame, sdmello@nd.edu
Art Graesser, University of Memphis, a-graesser@memphis.edu

Abstract: Much of the appeal of educational games stems from the notion that players are persistent despite frequent failure and the possibility of re-producing that persistence in education. Our workshop brought together researchers in the humanities, cognitive science, and educational psychology as well as industry producers to discuss what makes failure appealing, why failure relates to learning, and how to design for productive failure. We explained why players seek out failure in video games when it makes them feel bad and what that means for learning. Confusion, in particular, facilitates learning when experimentally induced via the presentation of system breakdowns, contradictory information, and false feedback in learning tasks with computer agents. Individual differences in motivation, however, moderate learners' adaptive and non-adaptive responses to failure. The workshop generated discussions on how research can inform design and provided an example of a math program strategically developed to foster productive failure.

Introduction

We could not learn without failure. In fact, trial and error may be the most fundamental learning mechanism in nature. It is how babies explore and get to know the world. What tastes good? What hurts? What makes us laugh? We try. We stumble. We revise. We try again. Sometimes we get it. Sometimes we abandon the task. If we only did things we already knew how to do, we would not learn anything. This kind of productive failure is prevalent in children's play and inherent in their games, particularly video games. Failure is the norm in most video games—success is the exception. How many replays does it take to complete a level of *Angry Birds* (Rovio Mobile, 2009) successfully? Players experiment with one strategy after another, making adjustments, trying again, keeping what works, and discarding what looks like unsuccessful ideas. It is a wonderful iterative learning process.

If only formal learning had such a positive relationship with failure.

Our workshop drew on the expertise of researchers in the humanities, cognitive science, and educational psychology as well as industry producers to discuss how to design for productive failure. Drawing from the book *The Art of Failure* (Juul, 2013), we discussed why video game players choose to engage in experiences that induce frequent failure. To explain the cognitive, emotional, and behavioral processes through which failure may promote learning, we presented research on the effect of confusion on learning as well as a study on how learners' motivation affects their responses to failure. Based on these presentations, about 50 workshop participants—including educators, researchers, and game designers—tackled three design challenges for promoting productive failure:

1. How can we keep the freedom to learn and experiment that we find in games, even when students are aware that they are playing in a context where they may be monitored?

2. How do we design games in a way that promotes mastery goal orientations?

3. How do we promote productive confusion, creating moments that are likely to involve failure in the short-term but can help students to understand concepts better in the long-term?

Wrapping up, we illustrated how research informed the design decisions made in *MATH 180* (Scholastic, 2013), a program strategically structured to promote productive failure.

The Strange Appeal of Failure in Video Games

There is a paradox when it comes to failure in games. We generally avoid failure, a condition that is prevalent when we play games. Yet we seek out games even though that leads to experiencing something that we normally avoid. Juul (2013) argues that failure in a game is unique. The paradox of failure in games exists partly because games implicitly promise that when we are stuck, we can remedy the problem if we keep playing. Part of the success of video games depends on cultivating a situation of trust, where players genuinely believe that they have a fair chance of overcoming failure within the time that they have available. The feeling of escaping failure (often by improving skills) is central to the enjoyment of games.

Failure is crucial to learning because it makes us see new details and depth in the game that we are playing through experimentation. Part of the reason that deep knowledge is more likely to be developed through failures than successes is because we are more likely to search for causes for failure than causes for success (Weiner, 1985). Whereas success can make us complacent and believe that we have understood the system we are manipulating, failure gives the opportunity to consider why we failed.

Workshop participants were given the challenge of designing ways to keep the freedom to learn and experiment that is often characteristic of games, even when students are aware that they may be monitored. To reduce the negative effect of monitoring on promoting productive failure, participants suggested allowing students to flag the parts that others can view, offer help, and evaluate. This would preclude continuous monitoring. Others suggested creating a climate to redefine mistakes so that monitoring has a different effect, such as by framing mistakes as desirable feedback that are necessary for learning and progressing.

Another challenge for game designers is to push players to engage in situations in which failure is experienced because overcoming failure can lead to positive affect and learning, even though the experience of failure does not feel good. Designer Soren Johnson of the *Civilization* series describes it as a general problem that players seek out the optimal path to play a game and stick to it even when they find it fundamentally uninteresting. The strategy of lumberjacking in *Civilization III* (Firaxis Games, 2001) is one such example:

> Civilization III provides a simple example with “lumberjacking”—the practice of farming forests for infinite production. Chopping down a forest gives 10 hammers to the nearest city. However, forests can also be replanted once the appropriate tech is discovered. This set of rules encourages players to have a worker planting a forest and chopping it down on every tile within their empire in order to create an endless supply of hammers. However, the process itself is tedious and mind-numbing, killing the fun for players who wanted to play optimally. (Johnson, 2011, p. 32)

If players can reach their goal in an optimal way without challenge, they often do not seek a more challenging route for that same goal. Such examples introduces some doubt about the completeness of the *reversal theory*, which claims that we seek low arousal in normal goal-directed activities such as work, but high arousal (e.g., challenge, danger) in activities performed for their own sake, such as games (Kerr & Apter, 1991). Player psychology is more complex than that, with competing short-term goals of avoiding failure and long-term goals of overcoming failure in a challenging activity. Failure in itself is rarely fun, so environments that allow players to acquire new skills through overcoming failure need to be strategically designed.

How Failure Impacts Learning: Cognitive, Emotional, and Behavioral Processes

It is appealing to recreate in educational environments the culture of how failure functions as a desirable feature in games given the potential adaptive effects of failure on learning. Drawing on two research strands, we discussed with workshop participants the cognitive, emotional, and behavioral processes during and after failure that promote learning. We first presented work on the effects of confusion on learning. Findings suggest that confusion can be successfully induced through different methods and that experiencing confusion during challenging learning tasks is crucial for learning. Second, we illustrated how learners’ motivation, as measured by achievement goals, influenced their reactions to failure while playing a collaborative game at a science museum.

Effects of Confusion on Learning

Learning environments that challenge students and create failures can cause students to stop, think, and revise their current understanding. Confusion is one affective state that is likely to occur during this iterative revision process. There is considerable empirical evidence to support the claim that confusion is prevalent during complex learning and related to learning at deeper levels. Confusion occurs when students confront contradictions, anomalies, and discrepant events that create impasses and when students are uncertain about how to proceed (Carroll & Kay, 1988; D’Mello & Graesser, in press; VanLehn, Siler, Murray, Yamauchi, & Baggett, 2003). Not all experiences of confusion are beneficial for learning, however. For example, if a pedagogical agent speaks in a foreign language that the student does not understand, hopeless confusion that does not benefit learning is likely to occur. In contrast, productive confusion occurs in situations that can eventually be resolved by the student or with scaffolding supports by the learning environment. Thus, it is not the mere experience of confusion that leads to deeper learning; rather it is the effortful cognitive activities (e.g., problem solving, deliberation, reflection) that learners must engage in to resolve their confusion that leads to learning (VanLehn et al., 2003; Kapur, 2008).

The challenge then, which was posed to workshop participants, is how to create moments of productive confusion and then provide the appropriate scaffolds to ensure that students are able to successfully resolve their confusion. Among the many ideas were three overarching approaches to designing for productive confusion: (1) present contradicting information, (2) present a puzzle (or puzzling situation) to be solved, and (3) present a challenging problem that is beyond the student's current ability level. For the presentation of contradictory information, suggestions included showing students' multiple methods of solving a math problem and then discussing why one method was more effective than another. This type of activity can help students to not simply recognize the correct solution method but also reach a deeper understanding of *why* it is the correct method. The presentation of a puzzle (or puzzling situation) and a challenging problem were similar in that the student would not be able to quickly and easily solve the math problem and would instead have to deliberate over what is known and what are the possible methods for solving the problem. For example, one group proposed presenting a crime scene type of scenario that would require students to use their math skills to solve the crime.

In research with learning environments that are not game-based, confusion has been successfully induced to create learning opportunities. Confusion was experimentally induced during learning through system breakdowns, contradictory information (Lehman et al., 2013), and false system feedback across a series of experiments. Space limitations preclude a detailed discussion of these studies; however, they all revealed that confusion induction and regulation was generally a successful learning strategy. Across all three methods of confusion induction (system breakdowns, contradictory information, false feedback), students performed better when they were in a confusion induction condition than a no-induction control condition. In addition, when trajectories of participant confusion over time were investigated in the system breakdown experiments, findings illustrated that participants who had partially resolved their confusion performed better on a comprehension task than their counterparts who could not resolve their confusion.

Although the workshop discussion and previous research have proposed several methods to create productive confusion during learning, there is still a great deal of work left. First, for any method of confusion induction to be inducing *productive* confusion, the student must be capable of eventually resolving their confusion. This then requires the learning environment to also contain methods of aiding confusion regulation for when students cannot resolve their confusion on their own. Second, there are many different types of individual differences (prior knowledge levels, motivation levels, etc.) and it is unlikely that one approach to confusion induction or regulation will benefit all students. Thus, the next step in this line of research is to determine the method of confusion induction and confusion remediation that will most benefit different types of students. Future research will need to consider individual differences among students in determining the ideal combination of confusion induction and confusion regulation to maximize learning.

Effects of Learner Motivation on Reactions to Failure

Addressing one facet of individual differences, we have looked at how learner motivation relates to gameplay and responses to failure in the context of collaborative games at a science museum. In particular, we assessed motivation through a measure of student achievement goal orientations (Dweck & Leggett, 1988). Researchers have distinguished two achievement goal orientations toward learning: mastery and performance. A mastery goal focuses on developing and mastering skills and knowledge whereas a performance goal focuses on appearing competent, such as by outperforming others or by avoiding appearing incompetent (Urdan, 2011). Research on achievement goals have suggested that mastery-oriented students thrive on challenge and often put in more effort after failure and process information more deeply, whereas their performance-oriented counterparts are more likely to respond to failure by holding back effort, declaring the task to be boring (Dweck & Leggett, 1988; Elliot, McGregor, & Gable, 1999). More specifically, those who adopt performance-avoid orientations of focusing on not appearing incompetent often attribute their failures to personal inadequacy such as intelligence, memory, or problem-solving ability rather than see failure as an opportunity for learning (Dweck & Leggett, 1988). While those performance-avoid students need more help, it is the mastery students who are more likely to seek help.

It remains to be known, however, if these motivational patterns play out in the same manner in game-based environments. Simulations at the Norwegian Museum of Science and Technology provided affordances for both mastery and performance goals, allowing us to explore how goal orientations function in a game context. The heat pump game (see Figure 1) was designed to help students learn about energy transfer and the relations among pressure, condensation, evaporation, and temperature. Students are challenged to keep the house temperature consistently warm throughout the year by physically rotating a metal crank to operate the heat pump at the appropriate speed and direction. This heats up or cools down the house as the heat pump inner workings dynamically move in real time in relation to the movements of the crank. The results screen following the game shows the percentage of time the house stayed within the desired temperature as well as a graph that highlights the amount of energy that was saved.

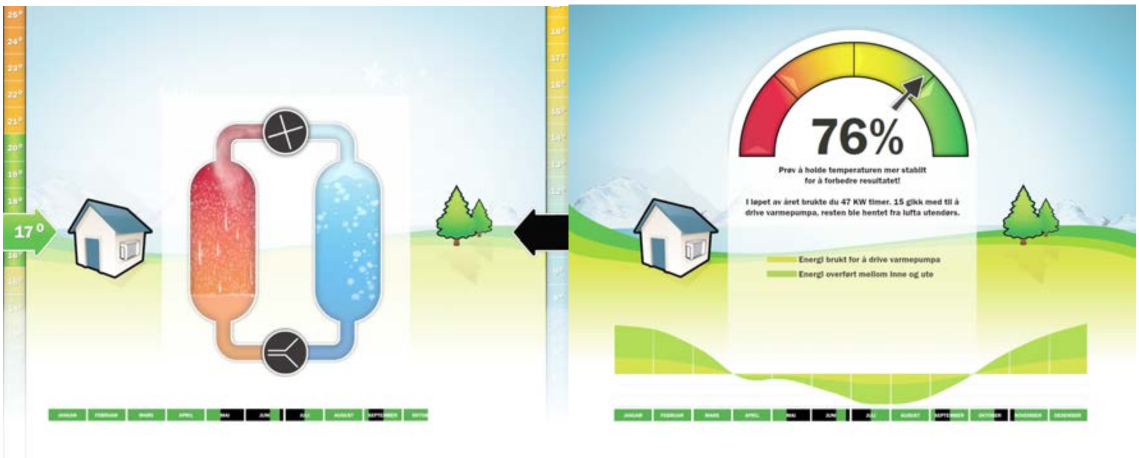

Figure 1: Screenshots of the heat pump game during play (left) and at the end (right).

Using principles of interaction analysis (Jordan & Henderson, 1995), we looked at how mastery and performance-oriented students (as indicated by self reports) interact with each other as well as with the digital artifacts in the games and simulations we designed. Preliminary video analyses and interviews with a subset of students revealed several types of information seeking after less-than-ideal game scores: *Social help seeking* (e.g., asking peers for help), *non-social information seeking* (e.g., looking at the digital simulation), and *vicarious learning* (e.g., watching someone else play to learn their technique). Within *social help seeking*, we have found *explicit* (e.g., asking a question) and *implicit* (e.g., saying I don't understand) examples. Within non-social information seeking, we have found subcategories of *active seeking* (e.g., testing out hypotheses by experimenting with the game to learn from game feedback) and *passive seeking* (e.g., reading the screen). Mastery oriented students engaged in greater number of different types of methods of help seeking to understand how the heat pump works and were more likely to seek explicit and active help to understand the scientific mechanisms of how the heat pump works. Performance oriented students sought information primarily through indirect social help seeking and passive information seeking to maximize their scores but focused on understanding the science when they thought that understanding aligned with achieving higher scores. As such, for performance-oriented students, it is particularly adaptive to have the science content and points be integrative rather than complementary.

To understand how motivation affects responses to failure in game-based learning, it is necessary to extend the current theoretical literature on achievement goals to that context. Interaction analyses contributed to a better understanding of how social dynamics and the physical and digital artifacts of the learning environment interacted with student motivation to affect their information seeking behaviors. Workshop participants discussed the challenge of designing games in a way that promotes mastery goal orientations. A major theme that emerged was reducing the negative impact of risk and incentivizing risk. Suggestions for encouraging risk-taking included incorporating a save element to reduce the cost of mistakes as well as rewarding experimental behaviors such as attempting several methods for solving the same problem. Others suggested allowing for mistakes that do not matter at the beginning, perhaps through an exploration phase of the game that is not tied to points. It was pointed out that in non-educational games, the consequences of mistakes are often much smaller and more manageable at the beginning and then grow as the game gets harder. Educational games may benefit learning by following a similar model. Understanding how students respond to failure and what influences them to adaptively respond to failure by processing information more deeply can provide insights about how to design learning environments that promote productive failure.

Designing for Productive Failure: The Case of *MATH 180*

Illustrating how insights and research on productive failure can be applied, we discussed how *MATH 180* (Scholastic, 2013) was strategically designed to foster productive failure. The math intervention curriculum blends teacher-led group instruction with personalized and adaptive computer-facilitated learning, exploration, and practice. Below we highlight how the program addressed each of the three design challenges described above.

1. How can we keep the freedom to learn and experiment that we find in games, even when students are aware that they are playing in a context where they may be monitored?

Even game players can become risk averse when they feel their play is being observed and evaluated. The classroom context matters (Steuer, et al, 2013), and the first two weeks of *MATH 180* are devoted to orienting students and teachers into the classroom norms and routines that foster a growth mindset (Mueller & Dweck, 1998) and establish a climate that respects errors as a natural part of learning. The individualized software reinforces risk-taking and personal growth through, among other features, the supportive guidance of an online host and coach and a feedback system that promotes self-monitoring, self-correction, and self-control.

2. How do we design games in a way that promotes mastery goal orientations?

Throughout the program students receive ongoing feedback on their personal progress and growth. A News Feed on the student dashboard provides personal daily reminders of recent mathematical achievements as well as new accomplishments that are within reach. A math GPS lets students know where they are in the program and shows the connections among their evolving mathematical network of knowledge. In addition a rich and transparent badge system (see Figure 2) honors students not just for improving their math skills but also for improving their perseverance and focus. Points, scores, and badges are all clearly tied to mathematical effort, perseverance, and performance.

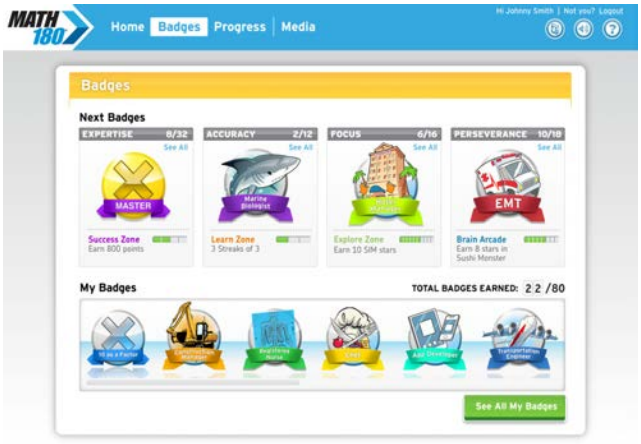

Figure 2: Screenshot of the student badge system in *MATH 180*.

3. How do we promote productive confusion, creating moments that are likely to involve failure in the short-term but can help students to understand concepts better in the long-term?

MATH 180 creates a culture that, like gaming, welcomes challenges, where confusion and struggle are natural and expected parts of the learning process. When students expect to struggle they are less likely to surrender in the face of obstacles (Wilson & Linvelle, 1985). In addition, the program incorporates tasks that are designed to generate confusion that is productive to the targeted learning. For example, one activity asks students which number doesn't belong in this collection: 9, 16, 25, and 43. The task has multiple "right" answers because 16 could be the oddball because it's even, 9 because its digits don't add up to seven, 43 because it's not a perfect square, 25 because the digit in the ones place isn't a multiple of 3, and so on. In the context of a traditional math class, simply having more than one correct answer could be confusing to students, and the program uses these multiple possibilities to encourage more student thoughtfulness and to give them practice consolidating and articulating their reasoning.

The software games also foster productive confusion. In *You're Toast* (see Figure 3), students must butter numbered pieces of toast from least to greatest, making strings of at least three.

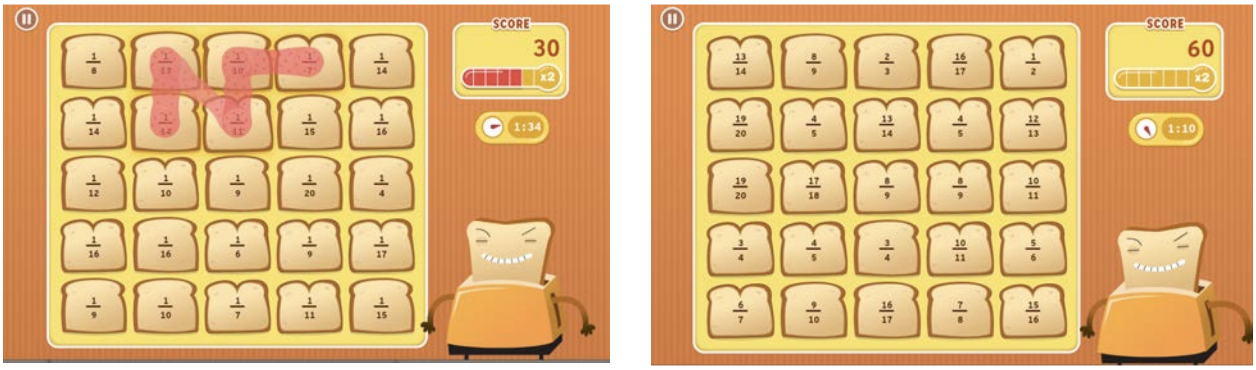

Figure 3: Screenshot of the game *You're Toast* in *MATH 180*.

Shifting from ordering whole numbers to ordering unit fractions creates some initial confusion because the larger the denominator, the smaller the fraction (5 < 8 but 1/5 > 1/8). Then shifting to ordering fractions one unit less than the whole generates another moment of confusion (4/5 < 7/8). This purposeful organization of content levels is meant to force students to reassess their thinking and break any over-routinized patterns.

Conclusion

Our workshop fostered conversations about how theories and research from different fields can help us design learning environments that promote productive failure. In doing so, we explored how these different perspectives build on each other, conflict with each other, and inform design in different contexts. Video games, for instance, differ from formal learning in that for the latter, while we may embrace errors as part of the learning process, making mistakes is not always productive. A challenge to incorporating productive failure in learning is that we need to consider that at some point we want students to master certain skills. In a similar vein, athletes and sports teams anticipate a learning curve as they develop their skills and game plans. The early practices might be somewhat experimental, filled with mistakes that are quickly corrected. Over time the number of mistakes diminishes, and by the time of the big match or game, execution should be error-free. We expect and tolerate failure within the learning process, but at some point what has been learned should become routine.

Perhaps where failure belongs in a learning progression is where gaming can have a natural home. In the progression from instruction to practice to performance, it is during the practice phase that the stakes especially need to be low, the consequences of failure nil. Students are playing to learn, to gain self-mastery. Their results should be guarded or at least under their control. As students gain competence, the stakes can rise until it is really time to perform. Future research can address how to strategically integrate games into the learning progression, taking into account individual differences in motivation, prior achievement levels, and context.

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ComputerCraft: Teaching Programming with Minecraft

Brendon Trombley, Don Miller, Institute of Play
brendon@instituteofplay.org, don@instituteofplay.org

Abstract: Computer programming is an increasingly important skill for young people to learn. However, it remains fairly inaccessible to the majority of learners. ComputerCraft is an add-on that adds working computers and robots into the popular sandbox game Minecraft. These objects are programmable through the Lua scripting language and can be used to complete tasks inside the Minecraft world. Through ComputerCraft, programming becomes an immediate and useful skill, allowing students to accomplish more in Minecraft's virtual space. This workshop models an introduction to ComputerCraft, aimed at educators teaching students. The players' first challenge is to create a "Hello World" program. Next, players encounter robots known as "Turtles", and learn to issue simple commands to them. Finally, players are challenged to program a Turtle to move along a predetermined path. As a result of these exercises, players gain an understanding of ComputerCraft, and by extension, computer programming in general.

Introduction

Computer Programming and Young Learners

Computer programming is an increasingly important skill for young people to learn. Learning to program opens more doors than ever before, and not just traditional computer science jobs like database programming. The Internet grows larger each year, and there is a need for both front-end (user facing) and back-end (server-side) programmers. In-demand creative coders are hired around the world at high-profile advertising agencies. The proliferation of smart phones proves that millions of people are exposed to scores of new apps and games each day. Additionally, the video game industry is not slowing down, and many triple-A games employ a great number of programmers in many different roles, from physics to artificial intelligence programming. Even indie games are breaking into the market as downloadable titles on just about every current generation handheld and home console. All of these jobs require people who know how to program. Many young people play these very same video games each day, with Minecraft being a very popular example. Dedicated players will spend hours creating virtual worlds in Minecraft. However, they may not completely understand how the game works behind the scenes. This is because computer programming remains fairly inaccessible to the majority of young learners.

Learning a programming language, even a simple one, can be a daunting task. There are hundreds of programming languages to choose from, each made for a variety of tasks. Setting up the software needed for the programming environment can be complex. After that, learning the syntax and the ability to debug can be an additional challenge. It requires hours of study even to produce simple results, which may not always prove interesting to young people. The amount of time required to become proficient and create games or apps is quite high, and even then, the results aren't normally as polished as games like Minecraft that so easily captivate their attention.

Minecraft

Minecraft is a indie game created by Markus "Notch" Persson, first released in 2009. Four years later it exists on many platforms and consoles: Windows, OSX, iOS, Android, and Xbox 360. It can be described as a "sandbox" game, allowing players to roam free and interact with the virtual world with little restraint. The world is procedurally generated and players can create constructions out of cubes made from various materials. Players are encouraged to mine to gather resources, as well as craft new cubes and tools. In survival mode players must gather resources and maintain their health. Creative mode removes those restraints and grants players the ability to fly and wield unlimited resources.

User-generated content for Minecraft is extremely popular and is one of the reasons the game continues to be well-liked years after its initial release. The content includes texture packs that change the look of the game, custom maps that mimic real world or famous fictional locations, and more complex modifications that offer new blocks, new enemies, and new ways to craft objects and weapons. ComputerCraft is one of the newer mods, being released in 2011.

ComputerCraft and the Lua programming language

ComputerCraft is a mod created by programmer Daniel Ratcliffe for Minecraft that adds computers, monitors, modems, and turtles to the game. All of these objects are virtual, but can be fully programmed and used to automate tasks that players in Minecraft usually execute manually while playing the game. Turtles can be programmed to dig, mine, build, and travel large distances automatically. All ComputerCraft objects are programmed with Lua, a real-life programming language that is easy to learn and high-level, meaning it is more abstract and reads like English. Lua is a programming language that was influenced by C++ and first appeared in 1993. As it is a fast-executing scripting language, it can be embedded easily in lower level (less abstract and more complex) C and C++ code. For these reasons, it is often used in video game development.

Together, Minecraft and ComputerCraft create an ideal programming environment for kids in a number of ways:

1. Many students are already familiar with and passionate about Minecraft, unlike traditional IDEs such as Eclipse.
2. Getting "up and running" with code is easy and straightforward after installing the ComputerCraft mod. No additional software is needed.
3. The use of code is simple and powerful with little fear of failure. Students can program robotic turtles to complete tasks with a few lines of code. Unlike traditional programming mistakes will not lead to software locking up or causing problems within the operating system.
4. Iterating the code is fast and easy, and changes are readily apparent. A student can quickly test a program, edit the code, and test it again to see the new results.
5. The "Need to Know" the learning objectives is strong. Students can use their new skills to design and execute solutions to in-game problems.

Minecraft and schools

At Quest to Learn, a NYC public school that incorporates game-based learning into its curriculum, Minecraft is used both formally and informally. In Sports for the Mind, a 6th-8th grade class centered around design and media skills, students play multiplayer Minecraft to develop their skills in collaboration and designing solutions to problems. Students have recreated NYC landmarks such as the Empire State Building, earned badges for working together as a team, and forged alliances with other groups of students. During lunch and after school, students flock to various clubs to continue playing or even learn how to make their own modifications to the game. Some students create new avatars or texture packs, while others delve right into the Java code that makes the game tick. Quest to Learn students and faculty alike find Minecraft to be a flexible, immersive, and highly engaging learning environment.

ComputerCraft Workshop

Workshop Plan

Participants in the workshop will take place in the Minecraft Tekkit Turtle Challenge. This challenge consists has four main learning goals:

1. Navigating the ComputerCraft OS
2. Writing programs in Lua
3. Learning the Turtle API
4. Programming a Turtle to accomplish a task

Our virtual ComputerCraft workshop has three main rooms, each containing several tasks to execute. Below is an overview.

Room 1

1. Using a computer - Players will find the computer block across from the starting point, and can begin using it by walking up to it and right-clicking. This will be present them with the basic ComputerCraft screen.
2. Navigating the OS - Players will type commands such as cd and ls to navigate directories and check their contents. See Figure 1 below.
3. Finding and running programs - With the help and programs commands, players will discover all the built-in features of the computer and learn a bit about its capabilities.
4. Writing your first program - Players will use the edit command to enter the Lua scripting interface. From there, they will write a basic "Hello world" program and run it.
5. Your program to-go - Players will learn how to use copy to transfer their program from the computer to a ComputerCraft floppy disk. They'll use this disk to carry their programs with them in the game world.

Figure 1: The TurtleOS

Disco Room

1. Intro to Turtles - Players will travel to a festively-lit room and encounter two ComputerCraft robots, known as Turtles. They'll learn how the Turtles act much like the computer they used in Room 1
2. Using a turtle - Players use a Turtle the same way they used a computer: by walking up to it and right-clicking.
3. Exploring the turtle - By using the help and programs commands, players will learn more about the built-in features of Turtles.
4. Starting the party - Players discover a command called dance built into the turtle. Typing in the command will trigger the Turtle to enter a dancing sequence, sliding and spinning around the Disco Room.
5. It takes two - Players can enter the dance command into the 2nd Turtle.

Challenge Room

1. Intro to final challenge - Players will travel to the final room which contains a Turtle, disk drive, and a glowing white pathway (see Figure 2 below). Their challenge is to program the turtle to walk the pathway.
2. Reminders - Players will be refreshed on the use of disks, cd, ls, and edit to write and save programs.
3. List of Turtle commands - Players will be introduced to the commands for this challenge such as turtle.forward() or turtle.turnLeft().
4. Commence challenge - From here, players will write their programs, testing and fixing until they get their Turtle to navigate the pathway (see Figure 3 below).
5. Extension - Players who complete the challenge early may use a loop to cause their Turtles to enter a looping dance at the end of the pathway.

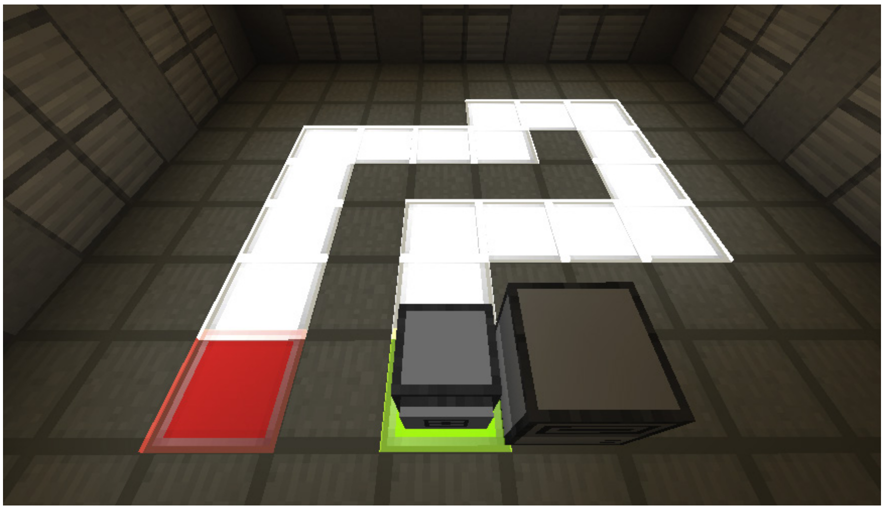

Figure 2: The Glowing Path

Figure 3: Turtle Commands

Playtesting Feedback

We playtested the demo with Ariel Kitch, a Sports for the Mind (design and media class) teacher at Quest to Learn. Here are some followup questions we asked, followed by her responses.

What did you learn during the ComputerCraft demo with Brendon?
I learned how programming turtles worked in Minecraft. I learned the basics of using computers and programming the turtles to do specific tasks.

How could you imagine this demo and/or ComputerCraft being used in your classroom?
I think the ComputerCraft mod would make a great immersive environment for students to learn basic programming once they know Minecraft essentials. I was really impressed with how the world made it easy to get involved in basic programming.

Why might you teach programming inside of a game world like Minecraft?
It gives students the ability to learn programming without worrying about text editors - thus it's a lot more accessible to students.

We also playtested the demo with some Quest to Learn 7th and 8th graders. Here is some notable feedback from those students.

What can your classmates learn from playing this demo?
Student 1: They can learn about coding while having fun controlling the turtle
Student 2: They can program easily

What was your favorite thing about the demo?
Student 1: Getting my turtle through the maze on my first try
Student 2: Making the robot spin

What was your least favorite thing about the demo?
Student 1: Having to type the same code over and over
Student 2: NOTHING

It's interesting to note that Student 1's comment about typing the same code over and over shows a potential readiness to learn new techniques that make writing code more efficient and reusable.

Lastly, we ran the ComputerCraft workshop at GLS 2013 with positive results. A large variety of people attended, from novice to expert levels of skill in Minecraft and programming. By the end of the workshop, the majority of attendees were at least partially through the final challenge. Afterward, number of people expressed the desire to use ComputerCraft with their own students, and several complimented the interactivity of the workshop itself. We received some constructive criticism regarding the somewhat quick pacing and high cognitive load for novice users.

Workshop Needs:
1. Attendees should have enough experience with Minecraft to know the controls and basics of navigating the environment.

2. They should download the zip file containing the workshop files. The location of file is forthcoming.

3. An internet connection for attendees during the session may be necessary

Acknowledgments

Thank you to Markus Persson and Mojang, the creators of Minecraft. Thank you to Daniel Ratcliffe, the creator of ComputerCraft. Thank you to the staff and students of Quest to Learn who helped with the playtests. Finally, thank you to Joel Levin, John Murphy, and Grant Tumen for their assistance during the GLS workshop.

SHORT PAPERS

Educational Game Arcade

Impulse

Erin Bardar, Jodi Asbell-Clarke, Teon Edwards, J.L. Larsen, EdGE at TERC
erin_bardar@terc.edu, jodi_asbell-clarke@terc.edu, teon_edwards@terc.edu, jamie_larsen@terc.edu

Abstract: Propel particles, avoiding destruction as you make your way to the goal. Take it fast, take it slow, just don't crash! *Impulse*, a blended-genre physics game designed for the web and mobile devices, is part of an NSF-funded research study to look for empirical evidence of learning fundamental high-school STEM content in games. We are using *Impulse* to test our assumption that we will be able to measure the development of players' tacit understanding of forces at a distance and Newton's Laws if we immerse them in a game where they must accurately predict Newtonian motion in order to succeed. As the game increases in difficulty through the introduction of additional particles and forces, players need to develop an increasingly sophisticated understanding about particles' behaviors in order to be able to predict their motions and safely navigate the player particle to the goal.

Introduction

Feeling Impulsive? Head for the goal, dodge obstacles in your way, and always remember, F = ma! Imagine you've been dropped in a sea of enemy particles. A bright light beckons in the distance. Your survival depends on your ability to avoid collisions and reach the safety of the goal before running out of energy. Figure out how the enemy particles behave and you just might make it out alive. Think you're up for the challenge?

Impulse is part of a larger suite of games being developed with support from the National Science Foundation to create games that teens (and the general public) like to play in their free-choice time, and are also designed to show empirical evidence of learning fundamental high-school STEM content. The research around these games focuses on the development and validation of a set of game-based assessments using an indwelling model of tacit learning that emerges through gameplay (Asbell-Clarke, Rowe, & Sylvan, 2013; Polanyi, 1966; Thomas & Brown, 2011).

About *Impulse*

Impulse is an immersive, blended-genre physics game designed for the web and mobile devices. Combining elements of puzzle, arcade, educational, and simulation games, *Impulse* places players in an N-body simulation of ambient particles obeying Newton's Laws (Figure 1). To advance, players must navigate their player particle (green) to the goal using a limited amount of energy. At each level, increasing numbers of "enemy" particles with different mass are introduced. Particles respond to the force of the impulse imparted by a player's tap or click, forces between particles (e.g., gravity), and elastic collisions between ambient particles. However, a collision between the player particle and any other particle results in an explosion and ends the game, sending the player back to a previous checkpoint.

Figure 1: *Impulse* game screen

Impulse requires the player to apply a force (an impulse) through a touch or click input. Players must use impulses to guide their particle to a goal without colliding with any other particles. Applying an impulse behind the particle will move it forward, while inserting an impulse in front of it will slow it down or make it travel backwards (relative to its initial direction of motion). However, every impulse requires energy, so players need to keep an eye on their energy bar and be strategic about where and when they create an impulse in order to have enough energy to complete the level.

Early levels of *Impulse* are designed to teach players about the game and basic science concepts. Checkpoints unlock new levels as players master the skills needed to advance. Level 1 teaches the player about their interaction choices by including only the player particle and the goal. This lets them play as long as they like without fear of particle destruction, but also see how the particle moves away from the impulse, how the location of the impulse affects the resulting speed of the particle, and how energy drains from the energy bar with each move the player makes.

Enemy particles of different mass (indicated by color and size) are introduced at successive level checkpoints, as players learn that colliding with another particle results in a game-ending explosion, but other particles can collide with one another. They also see how particle collisions influence the speed and direction of the particles' motions and learn that they can move any particle with an impulse, not just the player particle. At each level, more particles are added to increase difficulty. As the number of particles grows, it also becomes more obvious to players that there is gravitational attraction between particles.

Impulse Design

Impulse was created by a joint team of game designers, scientists, and educators who are trying to make a marketable, free-choice game (to be played outside of school), while also studying how learning a scientific phenomenon in a game compares to learning it in a traditional or an inquiry-based science curriculum. While there are plenty of other games that include elements found in *Impulse*, our overall goals led us to focus the game's design on just one set of principles (Newton's Laws of motion), without complicating factors such as dynamically changing mass as seen in Hemisphere Games' *Osmos* (2009) or friction as would be experienced in a real-world gaming experience like billiards.

In *Impulse*, as players determine the best path to the goal, they need to "study" the behavior of particles in order to be able to predict their motion and avoid them. More specifically, players need to predict motions that can be described by Newton's First (an object in motion or at rest will stay in motion or at rest unless acted upon by a force) and Second (F = ma) Laws of Motion, and a conceptual understanding of Newton's Law of Gravitation (the gravitational attraction between two masses is proportional to the masses of the objects and inversely proportional to the square of the distance between the masses).

Show Us Your Game Face

Impulse was designed with data collection in mind. We are using the game to test our assumption that we will be able to measure emergent, implicit cognitive strategies when players are immersed in a game where they must accurately predict Newtonian motion in order to succeed (see Asbell-Clarke et al., 2013 for details). To study players' understanding of the concepts built into *Impulse*, we are collecting and analyzing click-data as well as Silverback recordings (Clearleft Ltd., 2013) that include screen-capture video of gameplay, video of players' faces, and audio (Figure 2).

Figure 2: Montage of teens' faces during gameplay

We use the recorded playtesting data to code strategic gameplay moves. With coded clicks as "ground truth," we then use educational data mining techniques to predict those strategic moves and describe how strategies evolve as players advance in the game (Asbell-Clarke et al., 2013; Romero et al., 2010).

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Monsterismus: Recursively Relevant CS Game Design

Matthew Berland, University of Wisconsin at Madison, mberland@wisc.edu
Timothy T. Yuen, Don Davis, University of Texas at San Antonio
Timothy.Yuen@utsa.edu, Don.Davis@utsa.edu

Abstract: Monsterismus is an educational computer science (CS) game that represents an important step in advancing and developing video games to support CS learning. The development of such games is crucial as significant efforts must be made to promote students' interest in CS and to meaningfully involve students with more authentic programming tasks. Monsterismus provides a two-fold exemplar of best practices in computer science education for both novices and more advanced students. Namely, Monsterismus provides a more relevant and engaging context to engage novices with programming syntax and concepts. Secondly, Monsterismus is the product of students participating in authentic programming tasks, which is important for bolstering students' perception of relevance in order to impede CS attrition and support students' work place readiness. As such, Monsterismus represents the "recursively relevant" design of CS educational game.

The need to bolster CS participation

Many demographic groups are severely underrepresented among CS graduates (NSF, 2011), which negatively impacts the competiveness and responsiveness of US software manufacturers and represents a loss for consumers (Margolis & Fisher, 2003; Tornatzky, Macias, & Jones, 2002). Therefore, significant attention needs to be given to promoting underrepresented students' interest in CS both before and after matriculation (Beheshti et al., 2008; Margolis, Goode, Holme, & Nao, 2008).

Towards this end, Monsterismus exemplifies "recursively relevant" design of educational games in which both construction of the game and the resulting game provide relevant CS learning experiences. The game itself incorporates design elements to facilitate younger students' interest in and familiarity with CS. Further, the design itself was part of a capstone software engineering class, whereby students engaged in more 'authentic' agile software development whereby they were contracted to complete a software project in consultation with a client (the first author).

For younger novice CS students, the Monsterismus interface provides students with an 'authentic' purpose to engage with programming activities and concepts. Within the game (see Figure 1), students must program an avatar to collect various items (e.g. program a dragon to collect fruit and treasure). This is important because relevance, supported by authentic purpose, is especially important for students frequently underserved in US K-12 education (Ladson-Billings, 1995). Monsterismus serves as an authentic context as many students accept game narratives as a relevant and authentic purpose (Dondlinger, 2007). Therefore, by making programming an integral part of game play, Monsterismus provides students with an authentic context to engage with programming, which is necessary to generating and supporting interest in CS among underrepresented students (Goode, 2008; see also Ladson-Billings, 1995).

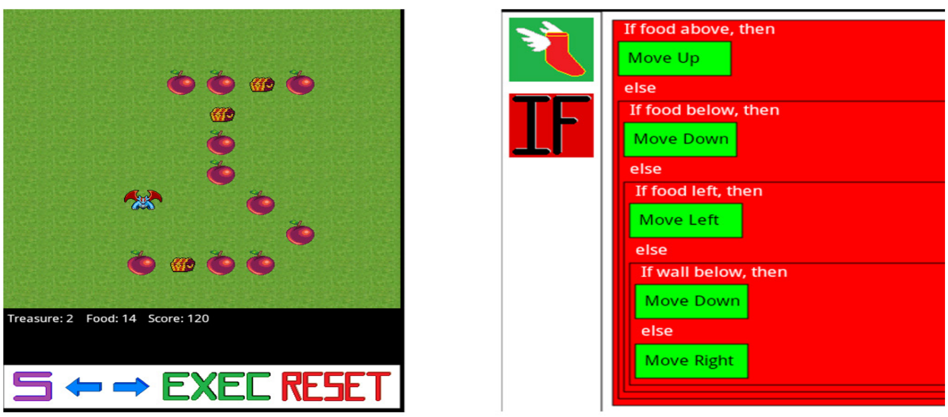

Figure 1: The Monsterismus Action Screen (Left) and Programming Screen (Right)

Moreover, Monsterismus' design reflects the understanding that any attempts to bolster participation in CS should be accessible to and promote the interest of younger learners for two significant reasons: 1) younger learners' interests significantly determine later STEM related career choices (Tai, Liu, Maltese, & Fan, 2006); and, 2) the lack of opportunities to meaningfully interact with CS at younger ages contributes significantly to CS underrepresentation (Margolis et al., 2008). For these reasons, Monsterismus provides an intuitive easy to use 'clickable' interface (see Figure 1), but strives to make significant CS concepts and verbiage, such as conditional statements (Goldman et al., 2008), apparent, else Monsterismus' connection to CS may be lost and so too any potential interest in CS careers it may have garnered (Eisenberg, 2003).

Additionally, the development of Monsterismus represents an effort to increase CS relevance for more advanced CS students. Namely, CS educators have highlighted the need to solidify more advanced students' CS interests and skills by engaging students in more relevant and authentic programming tasks (Fernandez & Tedford, 2006). As such, many CS educators recommend providing authenticity by requiring students to complete tasks in consultation with clients (Ellis, Morelli, Lanerolle, Damon, & Raye, 2007). Monsterismus successfully exemplifies this process as it was commissioned, planned, programmed, and debugged all within a ten week semester.

Monsterismus: Next Steps

Moving forward, Monsterismus' tasks, narratives, and interface will be revised in response to student feedback. Also, researchers will further ascertain students' perceived connections between Monsterismus and CS and the extent to which Monsterismus promotes interest in studying CS or pursuing CS careers.

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Quantum Spectre

Teon Edwards, Erin Bardar, Jodi Asbell-Clarke, and J.L. Larsen, EdGE at TERC
Teon_Edwards@TERC.edu, Erin_Bardar@TERC.edu,
Jodi_Asbell-Clarke@TERC.edu, Jamie_Larsen@TERC.edu

Abstract: *Quantum Spectre* (QS), part of an NSF-funded research study looking at engagement and learning in STEM games, is a puzzle-style game designed for the web and mobile devices where players use mirrors, lenses, and more to guide laser beams to colored targets. The science of light represented in QS is accurate, and we are collecting data to measure how players proceed in the game as part of understanding how people learn to deal with the scientific phenomena represented. QS also has level builders so players and educators can construct new puzzles. The story of QS's design is one of balancing the science, the learning, and the gameplay.

Introduction

In the depths of space, containment fields are degrading and spectres are threatening to break free! To re-establish containment, you must solve the laser puzzles that power the tanks (see Figure 1)*. Use mirrors, lenses, and more to guide laser beams to colored targets in this scientifically accurate and wildly cool laser game. Watch out for the spectres… they will haunt you!*

Figure 1: Scene from QS Intro

Designed for the general public, *Quantum Spectre* (QS) is a puzzle-style game. Each level requires the player to direct one or more laser beams to targets while (potentially) avoiding obstacles. That alone is not so different from other "laser and mirror"-puzzle games out there. What makes this one unique is its scientific accuracy, the crafting of the puzzles, their sequencing, and the advancement system to scaffold learning, and the integration of a story into gameplay.

Our game design philosophy is all about making games that people want to play in their free-choice time, while also engaging those players with science concepts, inquiry, and thinking. Through our games, including QS, players are offered opportunities to explore scientific phenomena in environments where they can develop intuitive understandings of scientific concepts. We are funded by the National Science Foundation to design a series of web and mobile games that focus on high-school science concepts drawn from U.S. standards for science education. In addition, our situated learning designs compel players to create their own learning environments and experiences—learning that is scalable and measurable.

About *Quantum Spectre*

In each QS puzzle, the player places and orients items from an inventory of optical elements, such as flat and curved (concave, convex, and double-sided) mirrors, lenses, filters, beam splitters, and more, in order to direct laser beams (see Figure 2). When the appropriate color laser beam(s) have reached all the targets, a level is complete. How well the player scores depends on the number of extra, unnecessary moves made. Replay enables players to look for a more efficient solution, improve their score, and build their understanding. And level sequencing carefully introduces, isolates, combines, and applies puzzle-solving elements and strategies to scaffold both in-game progress and science learning.

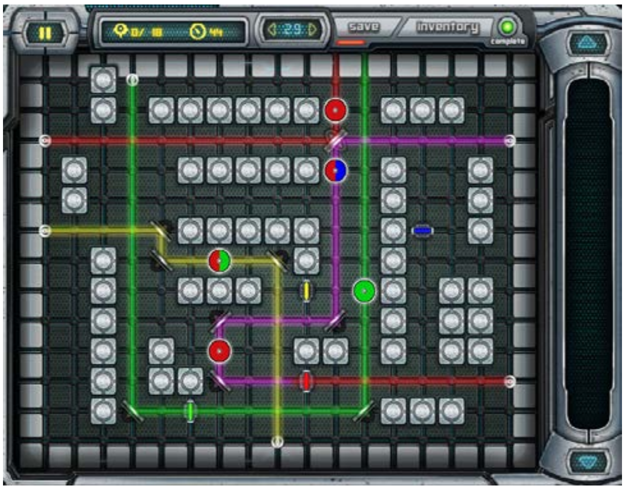

Figure 2: Sample Puzzle

The development team designed QS using a level builder. We are now working with teachers to design an interface to that level builder, which they can then use to create puzzles that support their curriculum. Players will also be able to use the level builder to design their own puzzles, which they can challenge others to solve, rate, and comment upon.

The Design of *Quantum Spectre*

QS is a product from game designers who are trying to make a marketable, free-choice game and educators who are funded by NSF to study how learning a scientific phenomenon in a game compares to learning it in a traditional or an inquiry-based science curriculum. This combination of constraints has led to some interesting design decisions for QS. For example:

Balancing science and gameplay

A laser-and-mirror game designed simply for good gameplay might tweak the physics to create clean puzzles. For example, the paths of laser beams might have simple slopes so that they cross grid nodes at regular intervals. However, this is not what really happens when laser beams interact with scientifically accurate curved mirrors and lenses. In QS, we dictated that the focal lengths of the concave mirrors be “nice”—e.g., one, two, and three grid squares (see Figure 3)—but because the curves of the mirrors mean that the reflection point is not over a grid node—except for the center of the mirror—the further a reflected beam travels, the more its path diverges from crossing the nodes. Challenges like this were things we simply needed to embrace as vital to the science and learning... and as an opportunity for making interesting puzzles.

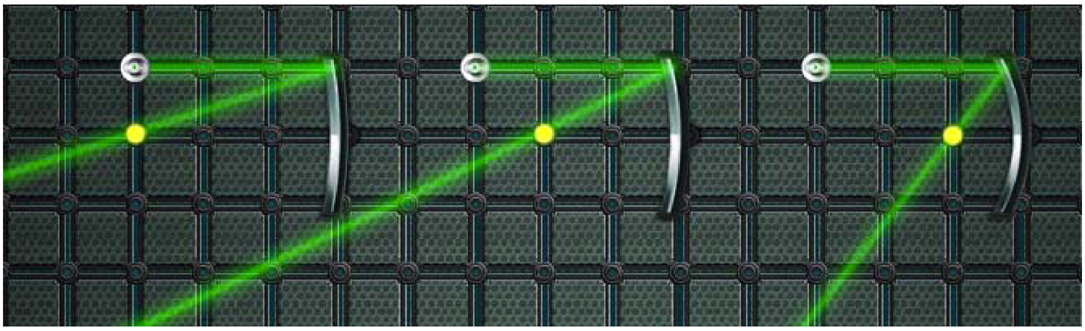

Figure 3: Concave mirrors with focal lengths of 3, 2, and 1 grid nodes

In-game science and learning

The science needed to make a game accurate is more in-depth than the science one expects a player to learn. For example, in science curricula, concave lenses are almost exclusively used with parallel beams coming directly into the lens and diverging symmetrically (see Figure 4a). From a strictly high-school-science point of view, covering this would be enough; however, from a true-understanding point of view, it is extremely limited, and from a game point of view, it is both boring and impractical.

In QS, the player controls the placement and orientation of the lenses, and laser beams travel along many different paths, so laser beams will be hitting the lenses at a variety of angles (see Figure 4b). The game must be able to deal with this, from the underlying physics to the puzzles that scaffold a player's experience, isolating the key learning without breaking the game and building a depth of understanding by taking advantage of the more complex situations.

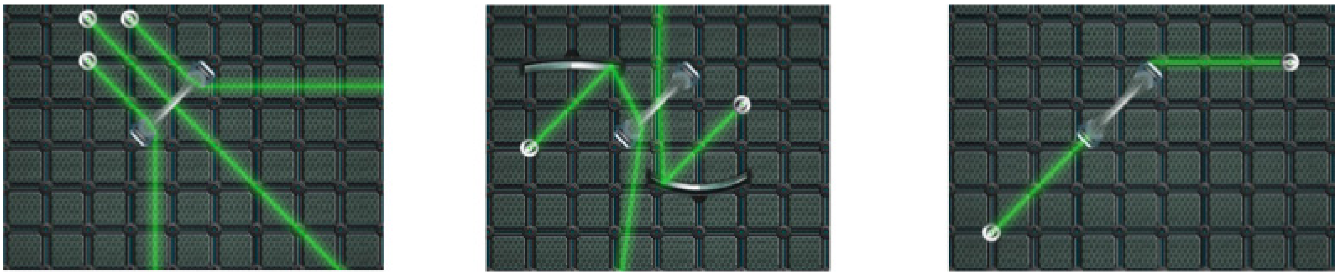

Figure 4: *Quantum Spectre* setups showing (a) "curriculum" parallel beams diverging, (b) beams at unusual angles, and (c) beams stopped by caps on the lens' ends.

At the same time, there have to be limits, and the selection and scaffolding of these limits are key design decisions. For example, on an optics table, laser beams can typically pass through the flat ends of concave lenses, but this is not the intended use of such lenses. By preventing this in the game with caps placed on the ends of the concave lenses (see Figure 4c), the designers are trying to isolate what makes a concave lens so interesting and important—the curvature of its surfaces.

Integrating the story

From the beginning, the game was designed to have a story, but it was not until feedback from early play testing that we realized how important (and useful) this would be. The design breakthrough that added the spectres to the game came from a combination of factors, including the need for the game to allow for trial and error while encouraging more efficient strategies. Later, design research provided information about players' perceptions of the spectres, resulting in another iteration of game design. The spectres and advancement system were designed—and tested—together, making the story an integral part of the game—making it *Quantum Spectre*.

Learning English Vocabulary: A Choose-Your-Own-Adventure Graphic Novel

Ira Fay, Fay Games, New Haven, CT, USA, ira@irafay.com

Abstract: With a development team of six people (two engineers, two artists, one writer, and one producer/designer) working for ~8 months, we created an English language learning game for Android tablets. The game, named *The Tomes*, facilitates vocabulary acquisition and retention by providing an engaging experience where reading and understanding vocabulary words in-context really matters: a choose-your-own-adventure graphic novel. Aimed at 6th graders in American public schools, *The Tomes* gives players the opportunity to make meaningful choices in a branching narrative. In addition, at certain points in the story, players complete timed minigames based on their knowledge of vocabulary, the result of which directs the outcome of the current plot and, behind the scenes, provides educators with useful assessment data. The game is completed and, as of January 2012, is being pilot tested in some New York public schools.

Overview

The primary gameplay of *The Tomes* is reading an animated graphic novel, inspired by the popular iPhone game *Surviving High School*. During the story, players make choices to direct the path of the narrative. From the Biemiller vocabulary lists for middle school students (Biemiller, 2009), the game highlights vocabulary words that appear in the story (see Figure 1).

Figure 1: *The Tomes* sample screenshot, having touched a vocabulary word

Players may optionally touch the highlighted words. A dialog appears with a context-sensitive definition, part of speech, sample usage, and correct pronunciation by a professional voice actor, not computer-generated speech (see Figure 1). Note that providing context-sensitive definitions is extremely time consuming from a content-creation perspective. Unlike a normal dictionary definition that provides many different variations and the reader is left to decipher the correct one, in this game, the reader is provided with the correct in-context definition, part of speech, and pronunciation. Though assessment data is still pending, we believe this in-context approach is superior to the dictionary definition approach.

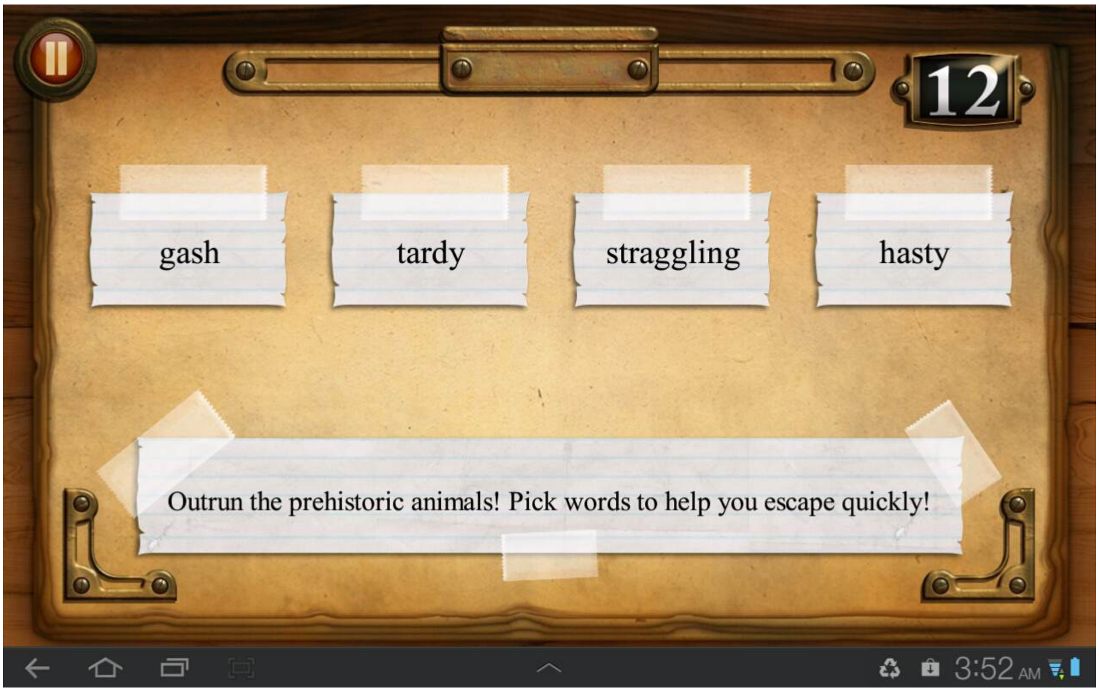

Figure 2: Timed minigame that impacts story outcome and provides assessment data

At various points in the story, players experience timed minigames. Players see an instructional sentence and four words, and then they must pick the correct word as many times as possible (see Figure 2). After each touch, new words appear, though the instructions remain the same. The instructions are relevant to the current plot of the story. After the minigame, the story branches in different directions based on the player's performance. Finally, to help manage the inherent complexity of branching storytelling, the development team created a tool to visualize the story. The automatically-generated story tree helped developers quickly identify problems in the story and balance different sections (see Figure 3).

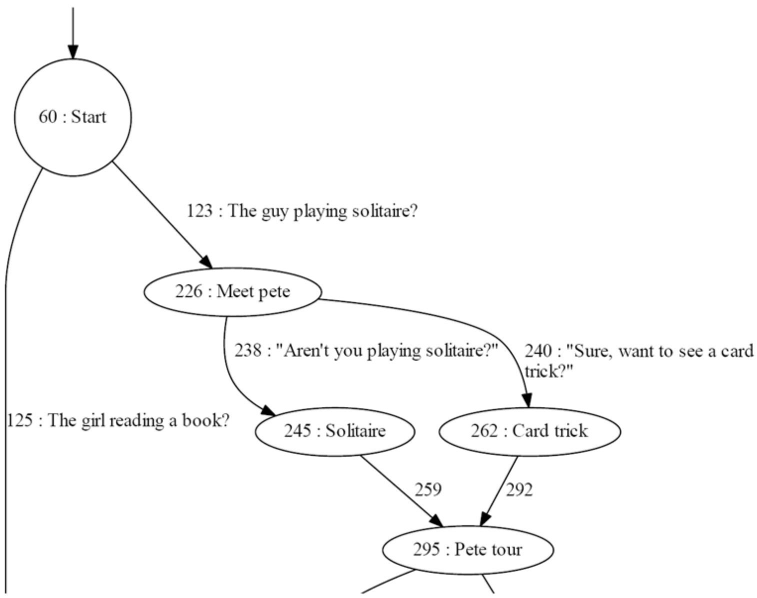

Figure 3: Output snippet from the story visualizer tool

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Learning Subject-Verb Agreement in English: An Archaeological Adventure

Ira Fay, Fay Games, New Haven, CT, USA, ira@irafay.com

Abstract: With a development team of five people (one producer/designer, two engineers, and two artists) working for ~6 months, we created an English language learning game for Android tablets. The game, named *Unearthed*, is designed to help 6th graders learn subject-verb agreement. The game has an archaeological theme and players reconstruct broken bones to form grammatically correct, though sometimes silly, sentences. As players match bones, they increase in level and unlock harder sentence constructions, like subjects with a compound OR. Also, players may periodically trigger one of three bonus games, which are designed to reinforce the educational concepts while providing a diversity of gameplay experiences. To ensure that very quick guessing isn't the optimal strategy, players earn a streak bonus for each correct answer in a row. The game is completed and, as of January 2012, is being pilot tested in some New York public schools.

Overview

The primary scene of the game takes place at an archaeological dig site with a top-down view (see Figure 1). Players touch-and-drag, touch-touch, or multi-touch bones to form grammatically correct sentences. At beginning levels, icons above the bones provide a hint about the grammar of that half sentence. Puzzle pieces with one prong represent singular nouns and verbs, and puzzle pieces with two prongs represent plural nouns and verbs. When the player makes a correct match, the pieces slide together satisfyingly. When the player makes an incorrect match, the pieces attempt to slide together and obviously fail to mesh.

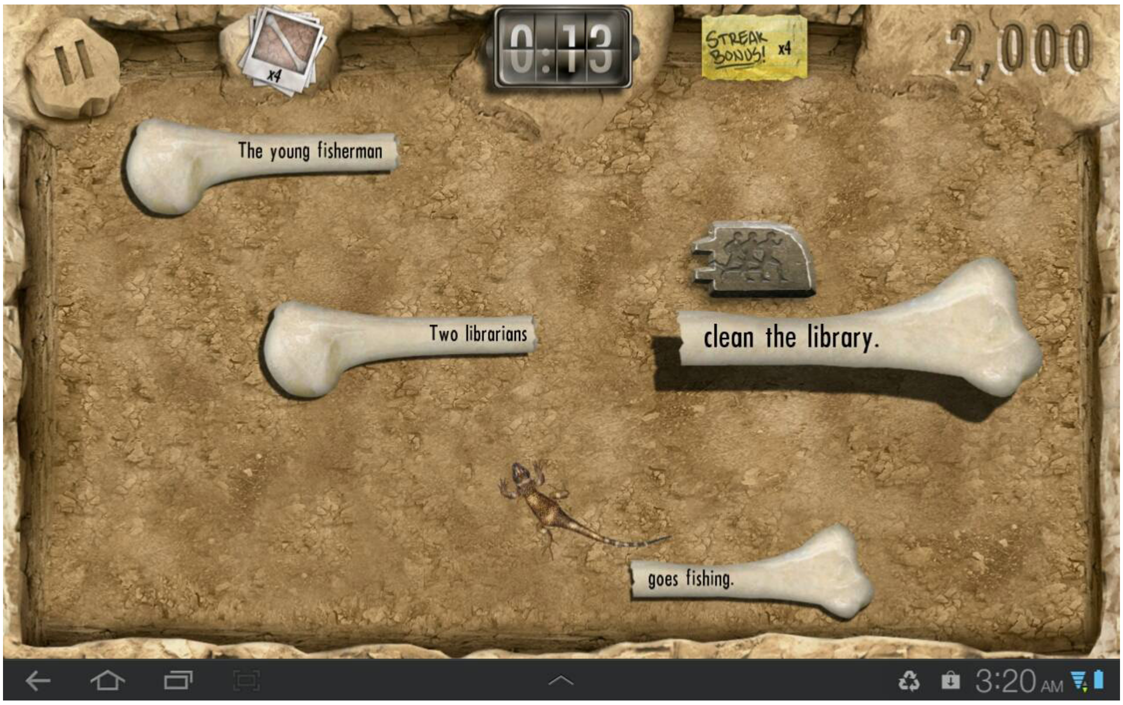

Figure 1: Sample screenshot of *Unearthed*

When a player touches the lizard that crawls around the playfield, a random minigame begins. In one minigame, the player must fill in a grammatically correct word from a selection of words floating in a water trough (see Figure 2). In another minigame, the player must choose between two words and pick the grammatically correct word to swap into the existing sentence. In a third minigame earned by collecting several artifacts that appear on the playfield, the player creates a mad-lib style sentence from scratch.

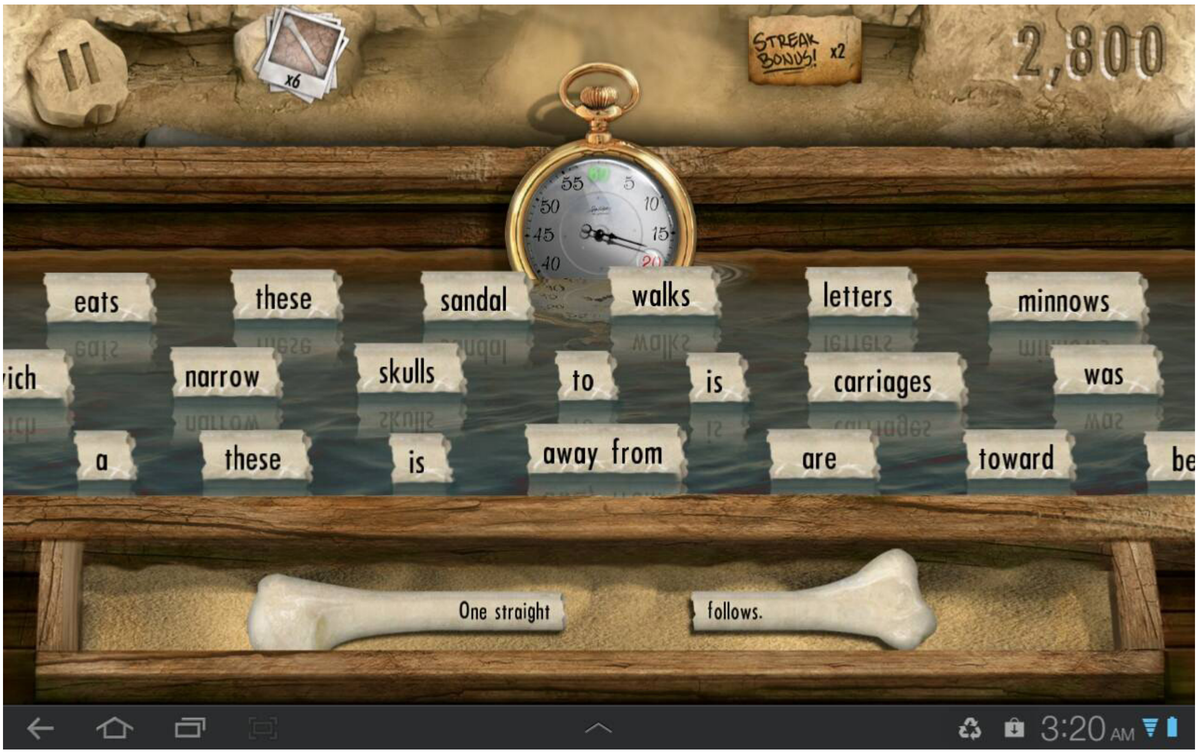

Figure 2: A screenshot of a minigame in *Unearthed*

At the end of each 60 second game, the game summary screen shows the player's score, lifetime progress, a review of the sentences formed that game, and tips (see Figure 3). To discourage mindless guessing, the game penalizes incorrect answers and rewards correct answers with a progressive streak bonus. For example, in 10 seconds, a player could guess quickly 20 times, making ~10 matches and ~10 mistakes, netting ~0 points. In the same 10 seconds, a player could think carefully, making ~4 correct answers with no mistakes, earning a much higher score.

Figure 3: Game Summary screen with score, progress, completed sentences, and tips

Understanding Environmentally Friendly Drilling through Serious Games

Luis Gaitan, Hannah R. Gerber, Sam Houston State University
gaitaneluis@gmail.com, hrg004@shsu.edu

Abstract: This session is an educational serious game that teaches players the concepts involved in environmentally friendly petroleum drilling. Petroleum calamities have happened since the early days of drilling. With catastrophic impacts in all the ecological systems, oil spills are some of the most devastating events through human history. Yet, there are diverse ways to avoid oil spills from happening, as well as methods to create eco-friendly drilling rigs. With these ideas, the oil rig serious game was born. The oil rig serious game application is necessary to educate the public and future energy industry workers on how traditional oil rigs can become more eco-friendly oil rigs, and create consciousness about what truly happens within an oil rig and within oil rig catastrophes. This application educates the public as well as those preparing to join the oil and energy industry.

What is the game about?

The oil rig serious game introduces the audience to the oil industry by allowing participants to explore a land based drill rig. This virtual land rig provides participants (players) diverse information about how a drill rig works, and allows them to try out the different types of machinery used on land rigs around the world. While players are immersed in the game world, the game program introduces a number of revolutionary- "eco-friendly alternatives"- to the traditional equipment currently used on rigs. In this case "eco-friendly" is defined as the alternatives that make a land rig create less toxic waste for the environment, and wastes the least amount of resources possible. These green technologies allow the rig to be more environmentally friendly, while also improving the safety of the personnel who are using it.

The game can also be used for training purposes: a player will experience a series of danger scenarios that culminate in the blow-out of the rig (see Figure 1). Through simulation, the game teaches the player steps necessary to prevent such accidents, and if they do occur, how to make it out safely. The serious game has been created to inform the public about the oil industry, as well as a tool to effect change in the way that the industry is currently marketed to future energy industry workers.

What is the purpose of the game?

The purpose of the oil rig serious game is used to immerse the player on a rig site and allow them to simulate the experience of walking through the environment. An example is when the player moves close to a piece of machinery, the sound of the machine gets louder as it would in a real environment. This gives the player the feeling that they are on the rig and immersed in the environment. When players approach an item/object it turns green, and if desired they can interact with it and gain additional information about eco-friendly options for that piece of equipment. Videos (cut-scenes) play, and players cab rotate and interact with 3D objects, read technical information, and access to a host of external links for more information on the subject.

The oil rig serious game is an opportunity to experience being on the oil rig and to experience both malfunctions and problem scenarios without being subject to the dangers inherent in an on-site visit. The application was created for use by a variety of individuals who work with rig environments: namely first responders and "rough-necks". First responders are those medically trained experts who respond in the event of a catastrophe and "rough-necks" is a slang-term for the individuals who work the hard manual labor on the oil rigs. The differences in use and approach in the game, depending on the role is that first responders will use the simulation rig to understand how a rig works, rig nomenclature, and safety procedures that need to be enacted should something catastrophic happen. Rough necks might use the simulation to learn the diverse equipment within a rig and each of its functions. Both groups, when playing the serious game, must successfully achieve the tasks for their role to minimize risks caused by the rig failure/blow-out.

What are the success and failures of the game?

Mechanical rig simulators cost up to six million dollars, yet the oil rig serious game costs a fraction of what a rig simulator costs. Additionally, the serious game is downloadable on any computer, and much like the United States Army's serious game *America's Army* (2002), the environmentally friendly drilling rig serious game will be made available to the general public to provide them with exposure to the industry and the environmentally friendly techniques that should be occurring; this will equip citizens with knowledge of environmentally friendly techniques available for the petroleum and energy industry. This provides multiple people, teams, and interested individuals the opportunity to experience working within an oil rig environment in multiple capacities through a variety of scenarios.

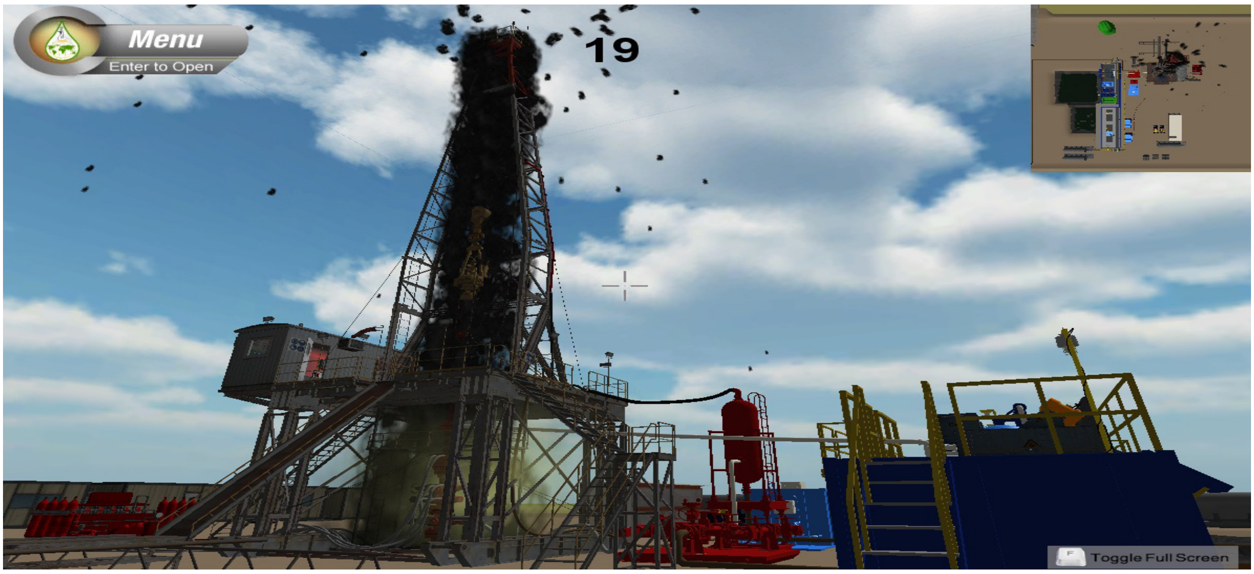

Figure 1: Screen-capture of rig blowout.

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Acknowledgements

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Covalence: An Organic Chemistry Puzzle Game

Jason Mathias, University of Southern California, Jason.Mathias@gmail.com

Abstract: *Covalence* is a game designed to turn the basics of Organic Chemistry into a mobile-style puzzle game. Intended to be played by OChem students learning the subject for the first time, the game draws inspiration from traditional chemistry notation such as line-and-dot diagrams, and integrates them with a 3D model of the system they're exploring, in an attempt to make the relationships between atoms and the complex 3D shapes that molecules take more understandable, through the lens of interactivity.

Game Format and Mechanics

Covalence is a digital view of what it would look like in a chemical mixture, with atoms floating in a solution, waiting to be bonded. The game has a casual writing style and its puzzles introduce each atom as a new character, similar to a new bird in *Angry Birds*. Puzzles are built around making certain shapes or realizing how many bonds a specific atom can take. It was designed as part of my Master's thesis for the Interactive Media program at the University of Southern California.

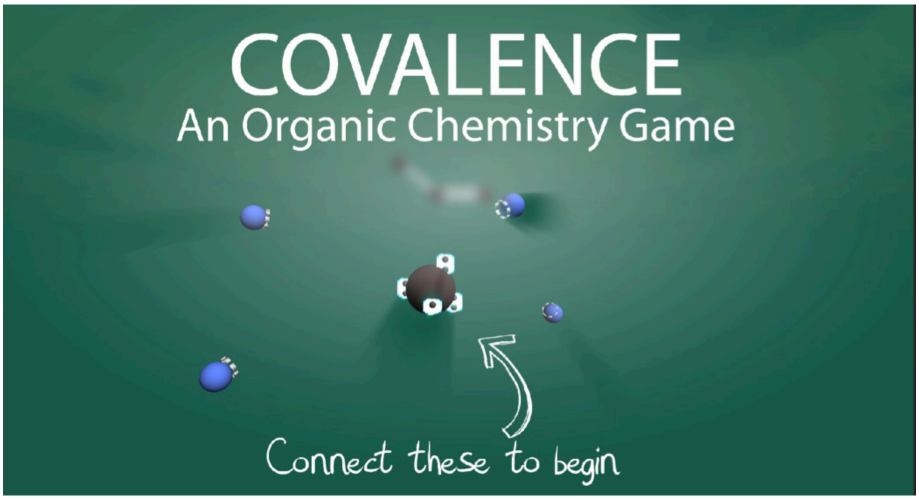

Figure 1: The start menu of the *Covalence*. Players bring enough Hydrogen (blue atoms) to the central Carbon (brown atom) in order to fully saturate the Carbon and form a molecule.

In most levels of *Covalence*, the player starts with a soup of atoms, some of which are unnecessary to complete the level. Levels require the player to make a specific molecule, a specific shape, or an arrangement of atoms, such that two molecules are either exactly the same or mirror images of each other. The player comes to associate certain atoms with shapes (Carbon, for instance, always makes four bonds, while Oxygen makes two, and they shape the molecules accordingly). The intention is for players to make these associations quickly and naturally, and hopefully take this knowledge into the classroom.

The game is intended to quickly get students up to speed on how atoms bond to each other, the shapes molecules take, and now to recognize the arrangement of atoms in 3D space. Over time, the molecules get more complex, and include puzzles built around understanding spatial arrangement.

Design Challenges and Approaches

Organic Chemistry is one of the most challenging classes in the college Pre-Med track, and a strongly feared college STEM course. A requirement for Admissions tests for Med school, Dental school, and Pharmacy, Organic Chemistry is widely studied by more than just Chemistry students. The subject is a complex study of molecular formations, spatial arrangements, and electromagnetic phenomena, and is unfortunately a roadblock that prevents many from pursuing a chosen STEM field.

Part of the difficulty of the course comes from the inherently 3-Dimensional nature of molecules, and the translation of that into traditionally 2-dimensional learning tools such as paper or the chalkboard. Shape and the arrangement of atoms in a molecule are extremely important in Organic Chemistry, and it's hard to see a 3D structure in 2D without some sort of approximation.

To translate the 3-dimensional molecule to the 2-dimensional paper or chalkboard, Chemists use a line drawing system, where bonds are represented as lines and atoms are represented as letters, and notations are used to show atoms that are 'in front of' or 'behind' the chalkboard. They may also use a system of computer-generated balls and sticks, which do a better job of representing 3-dimensionality, but still hide much of the information from the reader (such as where the other electrons are in the molecule). Even toy models that recreate the shapes of molecules hide valuable information, and this hiding can lead to confusion when understanding how the shapes form.

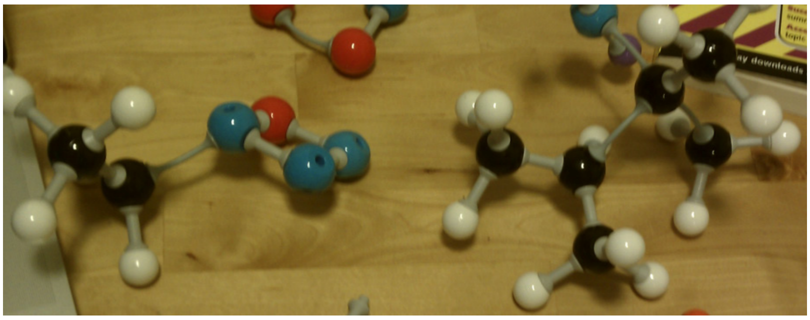

Figure 1: Line drawings (top) and physical models (bottom) of molecular formations. All three served as inspiration for the *Covalence.* Source: http://en.wikipedia.org/wiki/VSEPR_theory

In designing the game, then, I opted to show as much information as was necessary to understand the idea of bond formation. Bonds are formed via electron pairs (the number of which are specific to each atom). A bond forms by sharing the electron pair between two atoms, and molecules take shape based on how many bonds are connected to a specific atom. The game is intended to see atoms and their electrons as a sort of plug-and-socket relationship, so that the formation of atoms feels like a sort of 'underwater LEGO' game.

In addition, the game allows the player to fully rotate around molecules, getting a feel for their shapes in a manner similar to a physical model representation of them. However, it integrates information about electrons and their effect on molecule shape in a manner that most molecular model sets do not.

Next Steps and Future Application

Chemical reactions are largely based on the attractions of electrons between atoms, and I'm hoping to expand *Covalence* such that the game teaches fundamental Organic reactions. These reactions can then serve as mechanics in themselves, leading to puzzles where the player has to figure out what reactions to perform in order to make a certain molecule, an activity similar to the work that Organic Chemists in the real world do every day.

Acknowledgments

I would like to acknowledge Jeremy Gibson, Marientina Gotsis, Laird Malamed, and Dennis Wixon of the USC Interactive Media division, as well as Lisa Clements of Disney Educational Productions, for their help on this project.

The Fluid Ether: A physics simulation game

Kevin Miklasz, Iridescent, kevin@iridescentlearning.org

Abstract: We have created the first simulation game in a six game series based on various physics concepts. The *Ethers* series aims to bring the best parts of video games (goal-oriented play, open-ended challenges, a safe environment for failure, level editors, and performance before competence) to the world of physics education. The game comes with accompanying teacher resources for easy integration into the classroom. *The Fluid Ether* was created by a science education non-profit and is free and available for both computers and the ipad. The other five games, currently in development, will focus on gravity, momentum, projectile motion, electricity, and light.

Introduction

"*When we think of games, we think of fun. When we think of learning, we think of work. Games show us that this is wrong. They trigger deep learning that is itself part and parcel of the fun. It is what makes good games deep*." -James Gee 2007

Commercial games are effective learning tools, because they embody key learning features such as goal-oriented play, open-ended challenges, a safe environment for failure, and performance before competence. As a result, good games allow students to gain an intuitive understanding for a complex system through experiential play. Educational games that are appropriate for classroom settings rarely embody these features and fail to excite, as well as effectively teach, students. On the other hand, games that do embody these features are rarely classroom appropriate. Iridescent is developing six physics video games that embody the key learning features found in commercial games while focusing on classroom content and needs. The first game, *The Fluid Ether*, is complete and will be featured at the GLS Game Arcade.

For students, the game features two primary modes of engagement. First, students can engage in direct gameplay of the stock levels provided in the game. Second, students can create their own levels, adding to the content of the game and learning through creation. Teachers will also be provided with multiple resources to encourage adoption of the game in the classroom. First, teachers will be given an interface that tracks student progress and understanding as they engage with the game. Second, teachers will be give a sort of "lab manual" to structure classroom use of the game, including student homework prompts, discussion prompts and grading rubrics for student projects conducted through the level-editor. Third, Iridescent will provide professional development sessions for teachers to experience the game and create their own lessons surrounding the game.

Description of the game elements

"*Sometimes I was so involved with getting to the next level that I didn't realize what I was doing right, but as the game went on I saw the effect of manipulating water currents with jets.*" -Student tester of *The Fluid Ether*.

Open-ended sandbox style gameplay: A screenshot of the game is shown in figure 1. The game model is a physics simulator embedded in a sandbox style gameplay. Students manipulate the environment to move objects around and accomplish goals. For example players turn on and off jets to create fluid flow patterns that will move balls and accomplish tasks such as collecting coins and breaking blocks. Such gameplay encourages exploration of complex physics principles. For example by manipulating the fluid mechanics simulation, students learn that competing forces of drag and inertia increase disproportionately as ball size increases.

Deeper learning through challenge levels: The games will also feature challenge levels to test student knowledge. These levels will present one objective in a highly constrained format. Such levels will direct the student's attention to features they may have taken for granted, and it will subsequently test their understanding of those features. For example, in the "density" challenge level, a student will learn that balls of greater density have more inertia and take longer to accelerate. She will encounter a level with three balls of various densities, each ball in its own track and ready to be pushed forward by a jet with the tap of a finger. The goal is to make every ball hit the opposite side of the track at the same time. She will have to do this by turning on the jets in the tracks with high-density balls first, in the right order, and with correct timing.

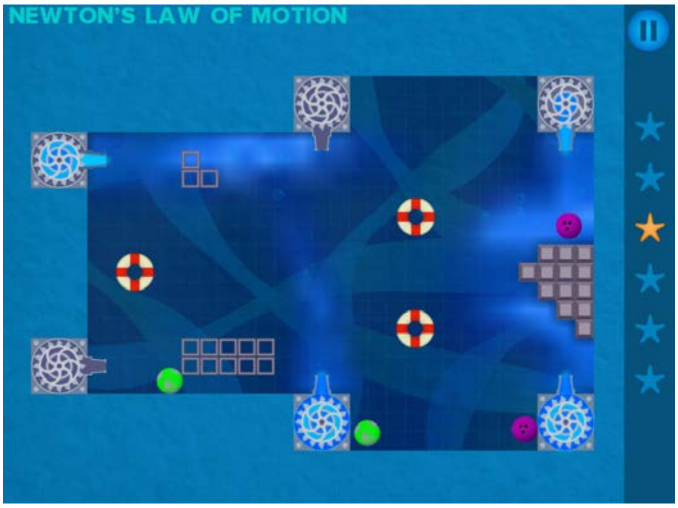

Figure 1: A screenshot of *The Fluid Ether*

In-game assessment: The game collects patterns of student play as they proceed through the game. When used in a classroom, this data can be pushed to a teacher's account, providing feedback on student progress to the teacher. In addition, such data acts as evidence of student performance and understanding. This can enable a transition towards in-game, evidence-based assessment, such that the act of doing functions both as learning, and as proof of learning. The data collection system is still being modified, and the author will share data collection methods with GLS attendees in the hope of developing a better understanding of what data to collect and how to collect it.

Co-creation through level editors: The game model will have a level-editor so that students can create their own levels, engaging them deeper in the physics and allowing them to engage in the design process. Students will be encouraged to customize the game to their liking and to add new challenges for other students to play. Teachers will be able to assign level-creation as a class project. A student-created level with an accompanying written or oral presentation will serve the same purpose in a science classroom that an essay serves in a reading classroom - a demonstration of understanding and synthesis of the topic.

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Quandary: Developing Ethical Thinking Skills Through Play

Scot Osterweil, MIT Education Arcade, Cambridge, MA, scot_o@mit.edu
Amelia Peterson, Harvard University, Cambridge, MA, akp546@mail.harvard.edu
Peter Stidwill, Learning Games Network, Cambridge, MA, peter@lgam.es

Abstract: How do you create a playful space that encourages children to recognize ethical issues and develop skills that enable them to deal with challenging situations in their own lives? *Quandary* is a unique game designed to do just that. Rather than teaching content knowledge, the *Quandary* story and mechanics provide much-needed opportunities to engage with ethical issues and develop skills such as critical thinking, perspective taking and decision-making. The game avoids teaching players *what* to think, and instead provides a framework for *how* to think.

A unique game for young learners

Quandary is a free, online Flash game in which players aged 8-14 shape the future of a new society while learning how to recognize ethical issues and deal with challenging situations in their own lives. Players lead a new human colony on a distant planet. They must make difficult decisions in which there are no clear right or wrong answers but important consequences – to themselves, to others in the colony and to the planet Braxos.

Quandary was funded by a private family foundation and produced by the Learning Games Network (LGN). It launched in September 2012. Scholars from Harvard and Tufts University devised and tested the initial prototype. Designers at the MIT Education Arcade and the Learning Games Network refined the game with artistic and technical production by FableVision.

Game design challenges

Skills, not knowledge

In both its content and design, *Quandary* was created to support the development of ethical thinking skills, which comprise a number of abilities including reasoning and understanding ethical problems (Staines, 2010). In regular conditions, our decision-making often relies on situational or emotional cues that can lead people to be unintentionally unethical (Mazar & Ariely, 2006). Practicing perspective taking and critical thinking together contribute to better decision-making. The reasoning skills that are the foundation of critical thinking are a very basic ability but are not necessarily utilized; only through practice does taking an abstracted approach become habit (Luria, 1976; Dias, Roazzi & Harris, 2005).

A playful space to investigate ethical thinking

The designers envisaged an engaging narrative that was both relatable but also fantastical, supporting engagement by being a source of novelty and aesthetic value (Bober, 2010). The game-world provides a space rife with ethical dilemmas and a diverse set of characters and perspectives. An initial character selection encourages involvement of the player's identity in the game (Gee, 2005).

Of the three scenarios currently in the game, the creators sought a balance between dilemmas immediately relevant to the target audience (e.g. the formation of cliques within a group) and novel situations (e.g. a predator attacking precious food supplies). A mix of individual, community and societal dilemmas was also sought.

Encouraging investigation and perspective-taking

Quandary's core game mechanic was designed to encourage player reflection. Having identified possible solutions and facts for a particular dilemma, players investigate the situation in order to make an informed decision. Players gain points by presenting possible solutions to the members of the colony in order to understand their perspectives. Players also gain points when they present a *relevant* fact to a character. A relevant fact makes a character think in more detail about the current dilemma, and may even change their opinion. Playing an irrelevant fact reduces the player's potential to gain points, thus encouraging thoughtfulness and reflection.

Figure 1: Interaction with the NPCs, their perspectives, solutions and relevant facts takes place through a digital card approach.

Success, failure and scoring when there's no clear 'right' answer

Players are taken through the stages of ethical decision-making: identifying facts and solutions, uncovering others' opinions, making informed decisions, and understanding the consequences. Although a player's decisions have a direct impact on the game world, a key part of the game is that there isn't one 'correct' answer.

If the player has carried out a thorough investigation - uncovered all the facts, and understood the various colonists' positions and concerns - then he or she is recommended to implement their chosen solution with modifications that address potential problems. If not, the player is given the go-ahead to implement the raw version of the solution. Hence a player's score is indicative of the process they went through rather than the exact choice they made. However well the player does, no ending is absolutely perfect, and not all of the colonists are pleased.

Facilitating discussion

Key to the success of *Quandary*'s mission is the conversations that occur around the game. The leaderboards and overall score across all episodes provide a way for players to compare themselves to other players, and understand that there are multiple routes to a successful outcome. A set of teacher materials was developed to support dialogue and discussions. These include a game guide, lesson plan, set of key discussion questions, and worksheets.

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Fair Play: Eliciting perspective-taking through gameplay

Dennis Ramirez, Clem Samson-Samuel, Sarah Chu, Belinda Gutierrez,
Justin Smith, and Sterling Pempe, University of Wisconsin-Madison,
John Karczewski, Adam Wiens, and Allison Salmon, Learning Games Network
dennispr@gmail.com, cgsamuel@wisc.edu, sarahnchu@gmail.com, bgutierrez@wisc.edu,
jds0102@gmail.com, spempe7@gmail.com, john@learninggamesnetwork.org, adam@learninggamesnetwork.org, allison@learninggamesnetwork.org

Abstract: *Fair Play* is a game in which people can explore what it means to be a minority in academic STEMM. As an African American graduate student, players will experience the hardships common to every graduate student, including the stress related to obtaining funding, writing papers on original research, and defining a unique scholarly identity. These experiences are embedded in a rich narrative that encourages players to take on the perspective of the main character. The goal of *Fair Play* is to raise awareness about people's implicit racial biases and to challenge players to identify and act on these biases in real-time. What implicit biases do people have? How do they affect one's academic career? What strategies exist to reduce such biases? These are the kinds of questions at the heart of the game.

Fair Play

Fair Play is a web-based game designed to reduce implicit biases (i.e., unconscious assumptions that arise from group stereotypes) against underrepresented individuals in academic science, technology, engineering, mathematics, and medicine (STEMM). The target audience for *Fair Play* is graduate students and faculty members in these fields.

The game draws from research literature on game studies and implicit biases to create a world that models the intersection of commercial game design and top tier research. The core of *Fair Play* centers on implicit biases and their effects on individuals in an academic setting. We all are biased to some degree, and these biases stem from stereotypes we inherit from our culture (Devine, 1989). For instance, studies show that the majority of Americans tend to have more negative implicit associations with African Americans than with White individuals (Nosek, et al., 2007). These biases, whether consciously endorsed or not, have a cumulative effect and contribute to the lack of diversity in academia (Minikel-Lacocque, 2012). The goal of *Fair Play* is to present biases in a realistic way through a rich narrative to raise awareness about their impact. By experiencing racial biases in the game, players will come to identify and learn the role that biases have in the lives of minorities in academia.

Figure 1: Jamal explores a location, the student union, in *Fair Play*.

Fair Play's gameplay and mechanics are inspired by point-and-click adventure games in which players explore the setting and embark on quests to advance the story. In *Fair Play*, players take on the perspective of Jamal Davis, a young African American student who has recently been accepted into graduate school and has plans to build a successful academic STEMM career for himself. Over the course of the game's five chapters, Jamal meets peers and mentors who can propel him to (or hinder him from) achieving his ultimate goal of presenting his first research paper at an academic conference. As Jamal, players must conquer each chapter's objectives such as finding an advisor and doing literature research for a paper while they witness how implicit racial biases may affect the undertaking and outcome of these tasks.

The game provides ample opportunity for players to experience implicit biases as they navigate the world of academia through the perspective of Jamal, particularly in conversations with other characters and through encounters with objects in the game environment. As bias scenarios occur, they are recorded in an in-game almanac along with their formal bias concept names and definitions for future reference. This information is particularly useful when players choose to identify, when prompted, certain biases they encounter – a correct (or incorrect) identification can influence future events in the game.

It is through social interactions with other characters, as a form of role-play, that *Fair Play* simulates real-life bias encounters. By actively assuming the role of Jamal and experiencing bias through his interactions, we hope that our players will gain increased levels of perspective-taking, empathy, and awareness of biases against underrepresented individuals.

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Micropresentations

TreeBit: A smartphone game with "evolving" pixel art to teach about life through time

Audrey Aronowsky, Beth Sanzenbacher, Johanna Thompson, Anthony Sixto, Noah Johnson, Ryan George, Edge Quintanilla, Mark Westneat, Field Museum of Natural History
aaronowsky@fieldmuseum.org, bsanzenbacher@fieldmuseum.org, jthompson@fieldmuseum.org, ajsixto@gmail.com, noahmjohnson@gmail.com, mailryangeorge@gmail.com, equintanilla@fieldmuseum.org, mwestneat@fieldmuseum.org

Abstract: *TreeBit* is a smartphone game designed to teach young adults about the framework central to all biology; the phylogenetic Tree of Life that shows how all species on Earth are related to one another. Evolution is central to *TreeBit* and, thus, to the game's design. Game art "evolves" from level to level with pixel art of increasing complexity. *TreeBit* has two components, 1) a Tree World framework that showcases the amazing diversity of life and shows the relationships among species and 2) game levels in which a player learns about important events in the history of life and unlocks sections of the Tree World. Each game level has different winning scenarios that unlock different portions of the Tree World, encouraging levels to be re-played for different outcomes. Here, we introduce *TreeBit's* concept and learning goals, and detail our early design decisions.

Introduction

One of the grand topics in biology is the detailed pattern of relatedness among life forms, reflecting the process of diversification which formed the evolutionary Tree of Life. These evolutionary trees, as seen in ToLWeb (tolweb.org), are the central framework for a wide range of biological disciplines ranging from medicine and pharmaceuticals to ecology and evolution. However, for the majority of people, the Tree of Life remains largely unknown. Here, we introduce *TreeBit*, a smartphone game designed to engage young adults with the Tree of Life through a combination of game levels and a framing game world. *TreeBit* blends an innovative art style, current scientific research, and progressive game mechanics in an educational game for mobile devices.

Visualizations and games to explain the Tree of Life are a hot topic and many projects are underway. Two projects are leading the visualization of large trees: *deeptree* (Block et al, 2012) and *OneZoom* (Rosindell and Harmon, 2012), which are focused on simplifying tree visualization and are not games. Other groups are developing games with explicit learning goals about the Tree of Life e.g., Harvard and Northwestern's *Build-a-Tree* and *FloTree* (see Perry, 2012 for a summary). *TreeBit* fills a niche by targeting a young adult audience, deploying on mobile devices, and tackling both tree visualization and gameplay at important points within the history of life.

The Game

TreeBit is a pixel-art smartphone game developed with the Unity 3D game engine. Currently in alpha testing on Android devices, *TreeBit* targets young adults ages 16-30. *TreeBit* is based in an evolutionary Tree World where players can explore the diversity of life by swiping and tapping on branches and nodes. To explore fully, players must unlock sections of the Tree by playing game levels. The levels use a simple input to gamify important branching moments in the Tree of Life. Because these game levels take place at particular moments in the history of life, they are tied to specific points in Earth's history (geologic periods). For example, to open the Tree World players must first complete a game in the Precambrian Period of Earth's history. The player controls three single-celled eukaryotes and must collect mitochondria and/or chloroplasts, avoid viruses, and get to the reproduction zone to win. Depending on which type of organelle the player collects (more mitochondria or more chloroplasts), either the plant half of the Tree World or the animal+fungi half of the Tree World unlocks.

Learning Goals

The development of *TreeBit* is centered around learning goals that include but are not limited to: 1) understand that life is diverse, 2) understand how species are related in a phylogenetic tree, 3) understand that the trunk and branches of the Tree represent an axis of time, 4) understand how certain abiotic (climate) and biotic (predation) factors affect speciation or extinction, and 5) understand that speciation and extinction can alter or create the structure of the Tree of Life.

Design Decisions

The history of life is a series of important events that led to the formation of new species (branching points) or the extinction of species (end of a lineage). Thus, many events could be included in *TreeBit* and the use of these seminal moments gives us the ability to expand the game almost infinitely. The variety of possible events posed a significant design challenge. With all of these options, where should we start? Initially, we chose to focus on better-known seminal moments such as: organelles and the evolution of single-celled Eukaryotes in the Precambrian Period, the evolution of jawed fishes during the Silurian Period, the evolution of flight in early birds/dinosaurs in the Jurassic Period, pollination and the diversification of flowers in the Cretaceous Period, and the evolution of leg length in horses during the Miocene Epoch. These examples appear in most text books and popular science literature, increasing the chances that our audience would have at least a passing familiarity with them.

Game Art

Another important design challenge was how to best represent the Tree World and game levels in an engaging way that aligned with our learning goals. We chose a pixel art style because of its popularity with our target audience. To promote the understanding that life changes over time, we elected to make the pixel art change as a player progressed through the Tree of Life (and thus through time). We selected eight major pixel art styles and mapped them to the geologic time scale. For example, a game level that takes place in the Precambrian Period (540 million-4 billion years ago) is styled after Atari games of the early 1980's, whereas a game level that takes place in the Jurassic Period (154-206 million years ago) is styled after Super Nintendo games of the 1990's. To our knowledge, utilizing an "evolving pixel art" style is novel. More importantly, this style draws upon the popularity of "retro" games and reinforces the idea that the Tree of Life represents an axis through time.

A Unifying Game Mechanic

Because *TreeBit* represents a great diversity of life through time (essentially different "characters" in every game level) and utilizes an evolving art style, we chose to unify the game through the game mechanic. But what smartphone game mechanic would apply equally well to groups as diverse as single-celled organisms and dinosaurs? And what type of mechanic could stand on its own and be a true game and engage and challenge the average player? We decided to start close to the base of the Tree of Life with a game level that focused on organelles and early eukaryote cells (described above). We developed a game mechanic that was based on a single input (swipe) controlling multiple players within the level. Then we tested that mechanic on a level involving more complex organisms, movements, and graphics (birds/dinosaurs in the Jurassic Period). Two factors influenced our choice of the second test level: 1) the immense popularity of dinosaurs and 2) the timing of that event (in the Jurassic Period) would require very different graphics from our evolving pixel art style. Through iterative development with feedback from limited focus groups with our target audience, we are finding that the unifying game mechanic is successful for these two vastly different times and organisms and is perceived as fun and addictive. As we build the next iteration of *TreeBit* we will test the mechanic and its appropriateness for our audience, assess if the game's learning goals are being achieved, and examine if we are engaging players in Tree of Life concepts.

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Emotional Graphs with Adapted PANAS Scale as a tool to Measure Emotional Affect within Educational Activities

Michaela Buchtová, Faculty of Arts, Charles University in Prague, michaela.buchtova@ff.cuni.cz
Cyril Brom, Mathematical-Physical Faculty, Charles University in Prague
Vít Šisler, Faculty of Arts, Charles University in Prague

Abstract: Positive or negative emotional affect seems to play important role in learning efficiency and motivation. To track emotional affect and compare it across different educational techniques, we developed emotional graphs with adapted PANAS scale as an evaluation tool, and tested it within experimental study comparing game-based learning, live action role-playing and classic lecture. The graphs can bring promising results for educational research; moreover it reveals interesting data about emotions crucial for learning, such as attentiveness, self-assurance and fatigue.

Background

Emotional experience during learning may have significant influences on learning outcome and motivation. Isen et al. (1978) suggest that a positive emotional state improved recall and positive emotions helped as retrieval cues for long-term memory. As positive and negative emotions can be activating (happy, angry) or deactivating (satisfied, calm), they impact learning activation (Russel, 2003). Moreover Craig et al. (2004) suggests that learning gains might be positively related to flow and slight confusion and negatively with boredom. Use of educational games and simulations for learning is well-evaluated for positive emotional induction (e.g., Eunjoon et al., 2012), but emotional state is mostly monitored within class observations or direct questioning that may not always provide comparable data and mostly lack the ability to capture inner emotional richness.

Emotional Graphs as an Evaluation Tool

To track emotional experience of learning we developed a qualitative measurement tool: emotional graphs; a modified Meyer's life-chart (Meyer, 1950) capturing respondents' positive and negative emotions and their development during the lesson. Meyer used graphs to correlate a psychiatric patient personal history and his/her subjective condition experiencing.

We piloted emotional graphs within a quasi-experimental comparative study conducted in 2011 on high-school students (N=74; age 16 – 18). The study (Šisler et al., 2012) compared various cognitive and affective variables. Students were randomly divided into two groups: experimental group used an educational game (*Europe 2045* featuring EU political and social affairs; *Orbis Pictus Bestialis* animal training; or *Bird Breeder* genetic heredity), while control group was taught the same topic by a classic lecture. After the educational session, students were asked to draw a curve representing their emotions/mood development during the session. They draw into a graph with horizontal axis representing a value of emotion on negative-positive scale (-10 – 0 – +10) and vertical axis capturing the learning time divided into three sections: before, during and after the lesson.

Students drew graphs with no problem and included many additional comments appropriate to content analysis. Within the study we revealed some problems taken into account in further adjustment of the tool: in the graphs appeared (1) huge individual differences in emotional range and (2) we experienced difficulties in evaluation of emotions and their polarization. According to (1) some students used the whole scale of graph, others worked with a short range. To specify emotional depth, we added a scale description where -5 – +5 was specified as a classic "school experience" and everything above/below as an exceptional experience. However the values are mainly subjective without any definitive significance, variations between different activities (e.g. learning session, break, etc.) proved more important. For (2) we supplied students with stickers of emoticons covering a 20-item scale of Positive and Negative Affect Schedule (PANAS). PANAS (Thompson, 2007) was designed to provide brief measures of positive and negative affects; and covers 10 positive and 10 negative emotions. To this list we added a fatigue, because it spontaneously appeared in many students' comments.

In autumn 2012 we started experiment, comparing learning experience and outcome of three educational techniques within theme of EU: (1) educational multiplayer role-playing PC game *Europe 2045* (exp. gr.), (2) classic lecture (contr. gr. 1), (3) live action role-playing game copying *Europe 2045* without PC (contr. gr. 2). The experiment is in progress thus we present the data concerning the emotional graphs within a limited sample (N=149). We expect final results in autumn 2013. The emotional curve for the classic lecture group peaked at lunchtime. The difference from other learning activities was in average 3.9 (SD=3.5), while in the contr. gr. 2 it was 2.6 (SD=3.2) and in exp. gr. 1.2 (SD=3.3). Students from exp. gr. did in the graphs minimally reflect a fatigue within whole educational program (Figure 1). In introductory morning part, students taught by classic lecture mentioned a fatigue in 29% of cases, while students from game groups only in 6% (contr. gr. 2) and 8% (exp. gr.). The most pronounced affection was experience of self-assurance (scale 0-1) with score of 0.1 (SD=0.2) for classic lecture gr., 0.5 (SD=0.3) for exp. gr. and 0.4 (SD=0.3) for contr. gr. 2. In content analysis of written comments we observed differences across the groups. While retrospectively evaluating beginning of the workshop, students from both game-groups mostly recalled and positively or negatively evaluated the introductory presentation about EU. But the classic lecture group used mainly comments about initial positive expectations. That may suggest a disappointment in the end of the day. Comments in the end part of the graph suggest a similar outcome. The students after the classic lecture added many comments showing joy at possibility of going home, students from other two groups commented the end of the workshop minimally.

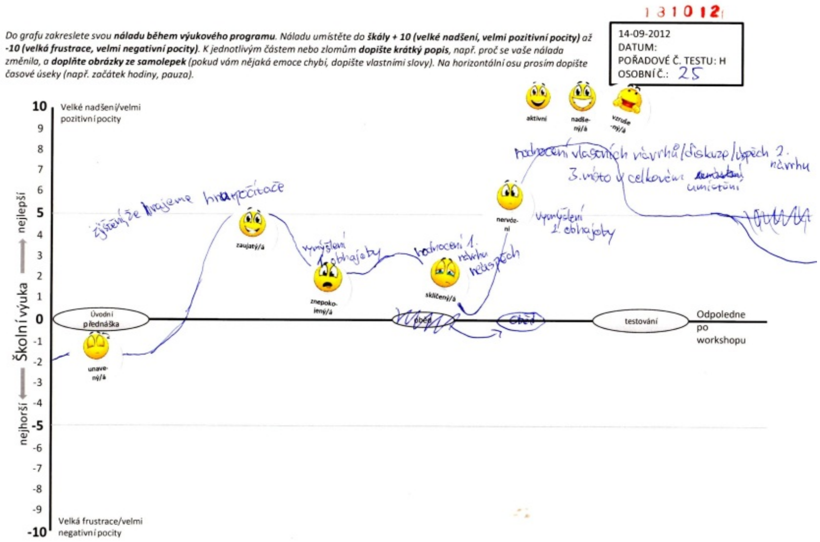

Figure 1: **Emotional Graph, experimental group.**

Conclusion

The emotional graphs can bring promising data into evaluation of educational activities. The tool allows for capturing the subjective evaluation of activities, the emotional changes and its sources, general positive and negative affects, self-assurance, attentiveness, fatigue etc. Furthermore our results indicate differences between classic lecture and game-based learning activities. Most notably, the games seem to activate self-assurance and reduce fatigue.

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From New Players to Fervent Hobbyists: BoardGameGeeks Unite!

Mark Chen, markdangerchen@gmail.com

Abstract: This is a call for more research on the growing world-wide tabletop gaming phenomenon, which includes sites of rich cultural production, nuanced emerging communities of practice, and examples of the kinds of varied and rich activity we want to see in our designed learning environments. Evidence that tabletop gaming is experiencing a golden age includes the prolific activity found on the website Board Game Geek (http://boardgamegeek.com/). This paper will present some of these activities and make a case for why "The Geek" serves as a mirror to reflect on more traditional educational settings.

Previous scholarly work on tabletop gaming includes using them as ways to teach computational literacy (Berland & Lee, 2011; Berland & Duncan, 2012), game theoretical analyses on designing for cooperative behavior (Zagal, Rick, & Hsi, 2006), using and designing board games for classroom use (Nicholson, 2011), and textual analyses of their embedded meanings (cf. essays in Costikyan & Davidson, 2011). Yet no one has stated the obvious: the culture and activity around tabletop games is extremely rich, dynamic, and prolific—as can be seen on the website Board Game Geek (AKA BGG or The Geek, http://boardgamegeek.com/, see Figure 1.); it demands academic research.

Like video games, a new generation of board games fall into various categories, both thematically and mechanically. Themes cover a wide range of genres such as Lovecraftian horror, spaghetti western, or corporate space exploration. Mechanically, games can be divided into many different genres that include resource management simulations, dice rolling, and role playing. Some of these games are cooperative, where all players win or lose against a scenario governed by game rules, while others are competitive, often featuring a victory point scoring system where winners are determined at a predefined end-game condition (Nicholson, 2008).

Generally, two schools of games talked about in BGG forums are *Euro* games that tend to focus on novel mechanics, open information, and strategically interesting decisions that require costs / benefits analyses and *Ameritrash* games that tend to focus on immersive themes. One area of possible research is whether the historical roots of these distinctions relate to the parallel narratology vs. ludology debate in digital games, though that debate is largely spurious at this point. Is narratology mostly an American thing (i.e., Ameritrash) while ludology more a European school (as represented in the Jenkins vs. Aarseth debate; HUMlab Blog, 2005)? Also, while these tabletop game categories are mentioned relatively often in the BGG forums, it is generally understood that individual players like all sorts of games, which may help us in thinking about different player "types" in digital games—perhaps it's another case of how context matters.

No matter a gamer's predilections, however, she can find a home at The Geek. Indeed, users of BGG share a love of tabletop gaming and feel a strong camaraderie with each other. Part of why BGG is so popular is its comprehensive user-generated database of games. In addition to adding material about individual games, users can ask questions of each other, discuss game releases, submit reviews, session reports, and house rules, and even upload PDFs or other files of fan-made cheat sheets or translations to game text. Users can accrue social and cultural capital through participating in the forums, where they can click a thumbs up button on individual forum posts and award GeekGold to other users. GeekGold can then be used to buy micro badges for one's profile next to an avatar. (i.e., a user controlled badging system!)

Perhaps most remarkable, a small group of Geeks engage in customizing and modding games, bridging paper and digital crafts through the use of design apps such as Adobe Illustrator and providing their new material for free to others in the community. Like customizing cars or doing casemods, there's little practical reason to engage in this activity other than the intrinsic enjoyment some users feel in improving their craft and showing off. They're *hobbyists* engaged in *serious leisure* (Stebbins, 1982). Some users also recreate and redesign artwork for out-of-print games (see Figure 1). These users also share tips and tricks for their craft, an activity akin to that found in DIY communities such as Instructables.

Yet these users did not start as expert hobbyists. In fact, it is possible to track new players' learning trajectories through forum posts that detail their rising skills and interests in the hobby. We need more research to see what maps onto academic models of community-based learning such as Lave and Wenger's (1991) description of legitimate peripheral participation.

The fervor found on The Geek is not unique. This kind of excitement is found in many online affinity groups. The issues this brings up for educators and designers of learning environments are of content and intensity of activity. First, why are schools seemingly continuously unaware of these crazy sites of rich cultural production? Second, why don't learners engage with learning content with as much fervor and self-directed agency? Finally, yes, we need more researchers looking at these pockets of rich, dynamic activity because 1) it's freaking awesome and 2) understanding the activities found on BGG and its social and technical structures that support these activities could lead to better designed learning environments that also wish to generate interest and passion with particular learning goals.

Figure 1: A screenshot of Board Game Geek's homepage (left) and an example of a DIY construction of a redesigned *Magic Realm*, an out-of-print game (right).

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On Asymmetric Multiplayer for Learning

Jason Haas, Massachusetts Institute of Technology, jhaas@mit.edu

Abstract: This short talk will focus on the value of engineering the interfaces and systems of learning games for the asymmetric distribution of information, control, and more. Games are often viewed as a way around the “one-size-fits-all” classroom, but make similar design choices, ultimately.

Why Asymmetry?

As complex multiplayer games arise due to technological advances and the emergence of a market for expensive, complex board games, designers are creating more and more ways to drive compelling multiplayer gameplay through asymmetry. Asymmetry can manifest itself as asymmetry of information, such as in many-against-one board game designs (*Buffy the Vampire Slayer, The Board Game; Claustrophobia*) or the (never-enforced) rules about card sharing in the collaborative board game *Pandemic*, or the distribution of tasks in the mobile device local co-op screaming game *SpaceTeam*. Asymmetry can also appear as the asymmetric distribution of power, such as in the *Game of Thrones* board game, in fighting games like *Godzilla: Destroy All Monsters Melee*, and in online multiplayer mayhem like *Team Fortress 2.* Asymmetry can also manifest itself in both these ways simultaneously, as in PVE raiding in *World of Warcraft*, where players have unique information and toolsets with which to collaboratively “solve” the problem of giant monsters in dungeons together. Asymmetry is of course also rising to the fore in local co-op multiplayer physical games like Die Gut Fabrik’s *J.S. Joust* and *B.U.T.T.O.N.*, both of which depend mightily on players’ physical prowesses and personalities, neither of which are necessarily apparent at the start of a game between strangers.

In this talk, I will quickly unpack these types of asymmetry possible and relate them to my Masters thesis work on *Sanctuary,* a two-player game for math and science learning. The game is played as a co-located co-op game in which players must solve a mutual problem managing a the economy and ecology of a local park, but they have asymmetric but interdependent tool sets, one deriving from biologist tools and the other from mathematical tools. In any game with emergent gameplay and properties, it can be said that no player has the same experience. Perhaps even without emergence, the mangle of player and game produce a wholly unique experience each time. Still, it is worth considering the possibilities inherent in providing radically dissimilar means of engaging with the same problems and systems from a new point of view. The theory behind this design is that asymmetric roles force players to collaborate and coordinate through language, thus ameliorating a longstanding problem with game-based learning. Too frequently, it can be difficult for players to be reflective about their game play in the moment, not formalizing their strategies and thoughts as they go along. By requiring players to formalize and express their thoughts in language, this should help players emerge from their experience with a more concrete grasp on their work in the game.

This, of course, is just the tip of the iceberg. I plan to leave the audience considering not just issues of coordination, but also of “fairness,” “incompleteness of experience,” and cheating. I will also leave the audience considering adaptability and possible additional engineering costs. Introducing many of these ideas and situations into existing classroom culture may create more problems than it solves. Asymmetry will not be described as a panacea for what ails experiential learning, but as a new path with a myriad of new benefits and challenges.

A Phenomenological Inquiry of Sound Within Educational Games

Jason Rosenblum, University of Texas at Austin
jarosenblum@gmail.com

Abstract: In what ways does sound affect our experiences of play within software-based educational games? This study takes a phenomenological approach to examine participant as they played games with and without sound. Three hundred and seventy eight horizons were coded across six interviews, and a rigorous phenomenological methodology was used to distill the horizons to the essences of subjective participant experiences with sound in games. These results reinforce findings from the extant literature on game sound in which sound reinforces critical aspects of game-play. Sound provided a sense of presence in the game environment, by offering participants an entrance into a coherent, immersive experience of gameplay. Sound and visuals cohered to create a unified perceptual experience that resulted in emotional connections with the plight of in-game characters, while the lack of sound left players wanting to learn more about characters they were trying to save.

Literature Review

This study explored a line of inquiry into the ways that sound affects our experiences of educational game-play. Research that is directly related to this question is rare. In 2008, Susan Bishop analyzed the relationship between uses of sound and the types of knowledge processing they supported across four educational game titles. Bishop's study helps us to understand that sound can be designed to support specific tasks while interacting with software (Bishop, 2008). However, the results from such analyses are unable to help explain the reasons *why* uses of sound might have such effects. Without such insight, it is difficult to design sound in ways that positively support learner experiences in educational games. Research that examines sound in educational software other than games does exist but focuses predominantly on questions of cognitive load (Sweller, 1988; Baddeley, 1992; Paivio, 1990). These questions can help us understand how much content to present through narration or on-screen text, but are inadequate in helping us to understand how auditory and visual information can work together to create engaging educational software. In contrast, game audio research offers further insight into the use of sound. Commercial game titles use sound in the form of sound effects and music to design game environments and support game mechanics (Collins, 2008). Music in games is carefully paired with visuals, and helps to provide emotional cues, foreshadow events, and sets the emotional tone of game environments (Whalen, 2004). Game sound effects are also critical in communicating information (Jorgensen, 2008). In her study, Jorgensen examined how people react when sound is taken away mid-way through game-play. When interviewed, participants described feeling a loss of control such that they felt "in the dark", and in one instance referred to the experience as "losing a leg" (Jorgensen, 2008, p. 166). Such descriptions of participant experiences are compelling, and thus form the basis for this inquiry.

Methodology

I chose phenomenology as the methodology for this study because of its ability to bring participant experiences to light. Phenomenology, according to Giorgi, is the study of the "totality of lived experiences that belong to a single person" (Giorgi, 1997 p. 2). To search for perspectives from experience is to search for the *essence* of a phenomenon; the "articulation, based on intuition, of a fundamental meaning without which a phenomenon could not present itself as is" (Giorgi, 1997 p 6). The process we take to engage in such a search necessarily involves a search for "all ideally possible perceptions" (Husserl in Moustakas, 1994 p 53). This application of phenomenology begins with a process to find "angles of looking" at a phenomenon *(horizonalizing)*, then reducing this initial set of perceptions into salient themes *(invariant constituents)* that through further analysis are described as the essence of a phenomenon (Moustakas, 1994 p 53). In this study I asked, *what are the essences of player experiences of sound in educational games*? I took a phenomenological approach to search for the essence of three perspectives of sound in educational games and explored the phenomenal meanings that emerged from their experiences of game play. I asked everyone to select and play two educational games across two 45-90 minute interview sessions. Participants first played each game with the sound turned off, then again with the sound turned on. I adopted a lightly structured, walk-through interview approach and I engaged people in a dialogue about their experiences with sound. The games that people chose to play included *Hush*, *Peacemaker* and *Alien Rescue*.

Data Reduction

I initially coded 378 references from transcribed interview data; each reference representing a unique horizon of participant experience. I eliminated 98 horizons based on relevance and further reduced the remainder into 12 overall themes to represent the final set of invariant constituents. These constituents ranged from the use of game music to support effective engagement to the use of game sound to provide immersion and impact and to help players to identify as in-game characters.

Essences of Participant Experiences with Sound

In this study, Thomas, Karen, and Anne shared their experiences of playing educational games with sound. For these people, sound allowed them to collectively pass through a gateway into the worlds presented to them to explore and interact within. The ability to hear the game, not just play it, enabled them to be fully *present* during play. They virtually entered and momentarily existed in the game space, connected with the embedded stories, identified with the plight of characters in the game, and in the case of Anne, felt the emotional contours left by the game after she left the first interview. They expected that the sounds they heard and visuals they saw would work together, and pointed out the times when they didn't. There were also times when sound wasn't present when they expected it to be. Karen thought the lack of sound in the space station in *Alien Rescue* made the station sound "…creepy". For Thomas, playing *Hush* with sound allowed him to gain entrance into the world presented, "I never thought of it like that before. You always hear about these war-torn countries…but it's like, 'Wow'…Much deeper than I thought it was going to be. Definitely went from a typing game to a, 'Oh wow!' This is a serious social issue." For Anne, her experience playing *Hush* with sound enabled her to connect with her own life experiences, "…I think that the first time I played it [without sound], I was intellectually there…But then when you go in [with sound] you can't help but understand it in a… much more experiential way that sort of touched not just my head but my heart, too."

Imaginative Variation and Implication

The visual and auditory gestalt of gameplay compels us to hear as well as to see. Sound marks our interactions, and signifies our choices. What we hear wraps us within worlds unknown. It enlivens game stories, bringing us closer to game characters, and encourages us to save the world.

Limitations

The results from this phenomenological approach used are not generalizable past these participants. Moreover, participant experiences could have benefited from deeper analysis of overlapping meaning units and greater attention could have been paid to participant experiences of gameplay and music.

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Gaming the Schools: Lessons Learned

Michael G Wagner, Drexel University, wagner@drexel.edu

Abstract: This paper presents four guidelines on the use of play and game based approaches in a formal educational setting. These guidelines address issues related to the potential as well as the limitation of educational games, the required competencies of teachers and trainers for using educational games in the classroom, as well as the limitations and requirements of educational game design as well as business development. They represent the results of a sequence of research and development projects performed over a period of six years.

Introduction

Even though first mentions of the importance of games in human und cultural development date back to Schiller's sequence of letters on the aesthetic education of man in the late 18^{th} and early 19^{th} century (Schiller, 2004) and the first applications of game based learning can already be found in the work of Maria Montessori in the early 20^{th} century (Montessori, 1966), we are just now starting to understand the true potential as well as the intrinsic limitations of play and game based instruction. The main driver for this development is the recent cultural emergence of video games. From applying core concepts of digital game based learning (Prensky, 2007) to utilizing game mechanics and game thinking in educational processes (Salen et al, 2010) the last decade has therefore seen a surge of play and game related approaches in formal education.

In 2006 we started a series of projects and studies funded by Austrian Federal Ministry of Education, Arts and Culture with the purpose of identifying the potential of game based methodologies within the established school system and formulating recommendations for educational policy makers. Our research activities involved several dozen schools and teachers and hundreds of students (Wagner and Gabriel, 2011). It included the introduction of game design and development as a mandatory school subject within a computer science focused high school, the in-class integration of educational games as well as off the shelf commercial games (Mitgutsch and Wagner, 2009), the gamification of learning management processes (Wagner, 2013), as well as the custom development of curricula based educational games (Wernbacher et al., 2012). The following presents the consolidated findings of these projects in a concise and digested, yet unpublished set of four fundamental guidelines on the potential and limits of formal game based education.

Limits of the Medium

While games can provide powerful tools for learning, their real potential, especially with respect to self-directed learning, is quite often overhyped. Learning with games as with any medium is a recursive process in which the learner is constantly reflecting on the learning progress. The success of this circle of reflection (Gee, 2013) depends on multiple factors, including personal preferences, learning environment, guidance by a teacher or instructor, and affinity to a particular medium used for learning. The actual medium or the underlying technology itself plays only a minor role in supporting a successful circle of reflection. We were able to show that any game can be used as an educational tool and vice versa, any so-called educational game can be used in a non-educational context without any educational effect. Being educational is therefore not a property of the game or the medium; it is a property of its use within an educational context. In some sense there are no educational or serious games, there are only games that are used in an educational or serious context.

Teacher Competencies

As the success of a game based approach in education does not primarily depend on the game itself but on the way the game is used, it turns out that teachers who want to use games for instruction do not need to be proficient gamers. In many of our studies we found that those teachers that had strong competencies in using media of any kind were also best suited for utilizing the full potential of games, independent of whether they were considered gamers or not. In fact, our most successful projects involved teachers or trainers that had little to no prior experience with digital games (Mitgutsch and Wagner, 2009). In every case we observed, however, these teachers were known to have exceptional competencies and experience in general media pedagogy and media didactics. Most of the time, successful teachers used games as one element in a mix of media and students were free to choose on their own, which medium they would use for what particular assignment or learning activity.

Economies of Scale

Because the potential of game based learning and instruction primarily depends on the way a game is used and not on the game itself, game based approaches in education are highly individualized by necessity. While this adds to the appeal of games in the era of competency-based education and individualized learning paths, it also has detrimental consequences for the custom development of games for learning. Due to this need for individualization, educational games in general cannot be mass-produced making the production of educational or serious games difficult from an economic point of view due to a lack of economies of scale. It is not surprising, that sustainable business models in this industry remain rare to find and difficult to develop. There are certain noticeable exceptions. The production of an educational game will provide sufficient scalability, for example, if the underlying business model includes elements mass individualization, such as through the integration of customizable didactic materials for teachers. Another option is custom development through a process we call iterative didactic design.

Iterative Didactic Design

In contrast to instructional design, game design commonly relies on an iterative development process model based on a playtesting phase (Fullerton, 2008). As any recursive model, iterative design seeks to heuristically optimize the parameters that are subject to change within a single iteration. In other words, the set of playtesting questions as well as the playtesters themselves become the driving factors for the development of the game. If, for example, the main emphasis of the playtesting phase is to evaluate player experience within a group of male adolescent playtesters, the corresponding iterative design process will tend to evolve the prototype into a game that optimizes player experience of adolescent males. Through the specification of the playtesting process, including the selection of the playtesters as well as the situation in which the playtesting takes place, iterative design is capable to custom design a game for a particular target group and application scenario. We were able to show that it is possible to setup the design process in such a way that it heuristically optimizes knowledge transfer within a certain educational setting (Wagner and Wernbacher, 2013). For this purpose, we enhanced the commonly used playtesting methodology with an educational evaluation including the analysis of motivational aspects such as self-efficacy or interest in subject matter issues as well as knowledge gains. It has to be noted that this approach works best, if the game concept exhibits a certain “didactic replayability”. In other words, learning has to occur incremental as well so that the didactic playtesting can be repeated with the same group of playtesters.

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Posters

Experiences of the Self in Affinity Spaces with Videogames

Carlos Baum, Poti Gavillon, Renata Kroeff, Cleci Maraschin, UFRGS
Baum.psico@gmail.com, poti_gavillon@yahoo.com.br, re.kroeff@gmail.com, cleci.maraschin@gmail.com

Abstract: This research aims to observe how the experience of playing video games makes perceptions of the self emerge and how these experiences provide conditions of normativity in affinity spaces arising from games. We understand normative capacity as the ability to establish other standards for other conditions, as a health production, which can be expanded through experiences with the different sets of rules of videogames. Through discussion of the concepts of normativity, experience of the self and affinity spaces, we seek to provide an important referential to support empirical studies on video games applied to areas such as health and education.

Affinity Spaces

The experience of playing video games also includes the social networks of interaction that occur around the games, called “affinity spaces” (Gee, 2003). Some of these spaces consist of forums on specific contents of each game. According to Gee (2004), the forums are formed by the sharing of content and actions rather than by identity marks or institutional ties. To be considered as affinity spaces, it is important that the forums have: participation open to any user; shared space for beginners and veterans; possibility to transform the environment, knowledge sharing among players.

Thus, different groups create different ways of participation, cooperating and/or competing, which may eventually stabilize ways of reading the technology. Therefore, literacy in the field of video games also involves examining the ideological aspects, of valuation of certain types of experience over other possibilities. The concept of affinity space does indeed challenge the stereotype of the player isolated in an individual experience. Games can be a source of agency of experiences, in a common level of action, where they operate as devices with the ability to aggregate and produce sharing.

Experience of the Self

According to Kastrup (2012) the experience of the self refers to a kind of self-awareness in the field of perceptive awareness, which should not be confused with a reflexive awareness and does not reflect the idea of changing the view that one has about him or herself but to noticing oneself doing things that he or she did not imagine would do. In terms of experience, perceptions and effects may surprise or bring questions, be they ideas or emotions. The experience of the self causes effects on the relation with the self thus opening areas of connection to the collectives, allowing actions of normativity.

According to Canguilhem (1995), the illness can be understood as the loss of normative capacity. In this sense, normativity actions refer to the possibility of establishing other rules in different conditions, becoming thus production of health.

When thinking these concepts in the context of interactive media, we believe that the experience of playing video games can make perceptions of the self emerge, enabling normative conditions in affinity spaces in which they occur.

In video games, the player is immersed in the specific rules system of the game. This set of rules may or may not be different from other rules systems with which he has everyday life contact. For example, in first-person shooters, there is a normative change of the action of killing, because it is not about annihilating the opponent, but defeating him. Therefore, what happens in the game does not refer to violence against each other, but rather to a narrative content between characters in the game.

These experiences of performing different actions in different sets of rules can configure experiences of the self, as the player finds himself doing something that he could not imagine himself doing in other contexts. Thus, the games allow practices of establishing new norms in different domains of experience, in other words, exercises of the normative capacity through the game. This characteristic is important, because the player is not only learning a routine of actions, but experiencing actions he would not do in other contexts, and therefore experiencing a new experience of the self.

Conclusion

In immersive experiences in video games emerges the possibility of experiences of the self and a perception of a plan of virtuality of the self, which appear as new experiences of the self in line with other current rules, not the usual everyday rules.

In this direction, some games have features that allow thinking the production of normativity, being understood as production of health. Experiences with games that have countless combinations of actions also allow countless possibilities of creating new perceptions of the self and, with these, new standards of life and relationship, intervening in the Modes of Subjectification of players.

An affinity space allows experiences of the self in a group that emerges from the encounter between its participants, whether in a forum, in an online game, or in face meetings to play. In this sense, video games allow participatory spaces that encourage interaction, communication and exchange of knowledge about the experience. Some spaces allow many ways to participate, encouraging feedback to game developers, which can lead to remodeling of the games. Some games are even designed to support players who wish to modify them, including tools for the "modding".

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Games for Development: Using the SGDA Framework to Assess Serious Games in ICTD

Kara A. Behnke, John K. Bennett, ATLAS Institute, University of Colorado at Boulder
Kara.Consigli@Colorado.EDU, JKB@Colorado.EDU

Abstract: Serious games are intended to fulfill a purpose beyond the self-contained aim of the game itself. The emergence of serious games as tools for international development calls for the tools to evaluate these games from both game design and development perspectives. This poster examines two serious games designed to leverage awareness of conditions in developing communities for socio-economic development in Sub-Saharan Africa. Using the framework by Mitgutsch and Alvarado (2012), we conclude that Games for Development (G4D) are uniquely challenged to respond to the objectives associated with good game design and the practices of effective development.

Introduction

This poster identifies the application of serious games within ICTD research and practice as "Games for Development" (G4D). ICTD is the research and practice that focuses on the use of information-communication technologies (ICTs) to improve the quality of life of people in developing regions of the world (Heeks, 2009). This poster applies the Serious Game Design Assessment (SGDA) Framework (Mitgutsch & Alvarado, 2012) to two games specifically designed for international development in Sub-Saharan Africa: *Freerice* (Breen, 2007), and *Raise the Village* (Sasvari & MacMillan, 2010). The authors chose to analyze these specific G4D because of the developers' intention to use monetary investment from the games' framework for social and economic development in Sub-Saharan Africa. This analysis considers how each G4D addresses design elements in relation to the game's intended purpose within the SGDA Framework and also considers the potential challenges in meeting ICTD social and economic objectives through a game.

Effective G4D: The SGDA Framework

Although prior work has focused on serious game design and design strategies (Kankaanranta & Neittaanmäki, 2009), only recently has assessment of serious games become the focus (Mitgutsch & Alvarado, 2012). Mitgutsch and Alvarado (2012) offer a template for assessing serious games in *Serious Game Development (SGDA) Framework*, proposing seven components of the conceptual structure underlying an effective serious game: the game's Purpose, Content & Information, Mechanics, Fiction & Narrative, Aesthetics & Graphics, Framing and the Holistic Game System.

Assessing "Purpose" of G4D:

Freerice is a free online game developed in partnership with the United Nations World Food Programme (WFP). Its purpose is to "help end world hunger by providing rice to hungry people for free" and to "provide education to everyone for free" (Breen, 2013). *Freerice* players play quiz games, and for every correct answer, collaborating sponsors donate ten grains of rice through the United Nations WFP. *Raise the Village* (Sasvari & MacMillan, 2013) is a city-building game intended to "help the population of a poor village in Uganda" (Sasvari & MacMillan, 2013). Players build a virtual village and help "build" the real Ugandan village of Kapir Atiira through in-game donations.

Assessing "Content" in G4D:

Freerice draws its information about world hunger from the research and statistics on poverty and starvation provided by the United Nations WFP (Breen, 2013). The information presented fact-based and accessible. In contrast, *Raise the Village* only provides information about the specifics of the Kapir Atiira village, poor living conditions, and everyday struggles with poverty (Sasvari & MacMillan, 2013).

Assessing "Mechanics" in G4D:

The goal of *Freerice* is to gain the highest level and highest score one possibly can, which in turns provide the maximum amount of rice donated to the WFP. The reward system draws on multiple levels of intrinsic motivation, incorporating the "feel good by doing good" motivation as the player supports relief-aid while learning new educational material. The goal of *Raise the Village* is for players to strategically build structures and balance beneficiary tradeoffs between items. However, neither game has an explicit “win-condition.” The authors note the absence of a way to “win” reflects the complexity of socio-economic development problems addressed by the games.

Assessing “Fiction & Narrative” in G4D:

Due to the inherent quiz-nature of *Freerice*’s gameplay, the fictional context of the game remains limited. The fictional context behind *Raise the Village* is designed around the non-fictional setting of the Kapir Atiira village. Although the game allows players to interact with a fictional “virtual village,” the game’s surrounding context repeatedly links the virtual-village to the real community in Uganda, and characters within the village are modeled after real people in Kapir Atiira.

Assessing “Aesthetics & Graphics” in G4D:

Appropriate cultural representation in G4D must reflect real people in the real developing communities. *Raise the Village* displays digitized images of real people in the Kapir Atiira village. The use of these images raises question relating to personal identity protection, protection the rights of vulnerable populations (especially children), and informed consent. Further, this blurring and melding the real “site” (Nakamura, 2002) and the virtual “sight” (Nakamura, 2012) may tend to anchor the game player in a Western, and even colonial, perspective. In contrast, *Freerice* uses only “real” images of people in developing communities.

Assessing “Framing” in G4D:

As is true for entertainment-oriented games, it is important to balance the difficult levels and incitements for game replay in G4D. *Freerice*’s level of difficulty increases from level to level, which balances the appropriate level of play depending upon the player’s play literacy, enabling gameplay to be challenging yet suitable for a variety of target audiences. In the case of *Raise the Village*, the game appears to be designed for experienced game players who are familiar with simulation-city based games and social-networking technology.

Assessing “Holistic Game System” in G4D:

Both *Freerice* and *Raise the Village* present a coherent and cohesive game system. *Freerice*’s framework is consistent with the content and core mechanics of the game. More could perhaps be done to utilize narrative to structure the learning experience of development issues for players. *Raise the Village* presents an environment for players to learn about the harrowing conditions and humanitarian crises through entertainment; these efforts can inform, and ultimately lead to an increased awareness and activism related to those crises.

Conclusion

Games for Development represent a potentially powerful and effective tool for achieving development objectives. Games’ ability to immerse players in experience, to simulate entire worlds, and most importantly, engage and inspire broader audiences, offers an engaging vehicle for ICTD. However, G4D also pose unique challenges in both design and implementation of the design and technology. Future research is needed in order to assess whether G4D can truly engage and educate players about serious topics, and how G4D are interpreted and reified by people within and outside the developing communities.

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GETUP: Health Gaming for “*the Rest* of Your Life”

Cynthia Carter Ching, University of California Davis, ccching@ucdavis.edu
Robin Hunicke, funomena, hunicke@gmail.com

Abstract: This poster articulates the problem space of designing a game to address adolescent health and health-related behavior, and shares the particular approach that this team has come up with to address these critical questions. Through the examination of one exploratory study at an urban middle school on the West Coast, the poster also outlines some logistical challenges in research and game design involving personal activity monitors and limited computing resources in a low-SES after-school context, and describes some contributions around youth engagement with gaming, health, and identity.

Public Health as a Context for Game Design

Health during childhood is a critical predictor of disease onset in later adulthood. Given the current rate of chronic disease onset in the U.S., the present generation of children, on their current diet and lifestyle trajectory, is predicted to live shorter lives than their parents (Olshansky et al., 2005). Schools might seem like the obvious place to address these conditions among children and youth, but studies in health education have found that school-based attempts to impact children’s activity levels and food choices have seen limited success (Ebbeling, 2002).

In recent years games have been vilified for their correlative relationship to childhood obesity, via studies wherein children who report playing videogames frequently are often also overweight or obese (Vanderwater, Shim, & Caplovitz, 2004). In response, a new wave of game systems that are based on sensors and kinesthetic controls (such as *Wii Fit*, *Dance Dance Revolution*, *Xbox Kinnect*) shift the nature of typically sedentary activity while gaming. Yet even if these kinds of games can increase players’ energy expenditure while gaming (Leatherdale, Woodruff, & Mansky, 2010), there is still the question of how to positively affect the health behaviors of players during the times they are *not* playing—or, as a participant in our project put it, “There’s games, and they’re cool an’ stuff, but then there’s like *the rest* of your life.”

Gaming with Personal Activity Monitors

GETUP stands for “Gaming to Educate Teens about Understanding Personal health.” An approach that holds promise for connecting gaming behavior and learning with players’ physical activity in their non-gaming lives is the use of physical activity monitors. Monitors such as the fitbit (see Figure 1) record users’ steps walked, floors climbed, calories burned, miles traveled, etc.

Figure 1: The fitbit “One” activity monitor

While some game design efforts involving fitness devices have focused on making the act of exercise itself more game-like (see review of “exergames” by Oh, 2010), our approach is instead to make the synced data from these fitbit activity monitors available for use in a more traditional online game space. Together, researchers and professional game designers are creating *Terra*, a narrative-driven online game, playable on any internet-enabled device and browser, in which teams of astronauts travel to an uncharted planet to build a base, explore the terrain, and terraform it, along the way avoiding disasters and encountering new landscapes, unfamiliar food sources, and alien creatures. As the action unfolds in the game, and as players wear their activity monitors on a daily basis, personal activity data from previous device syncs become available in the game, on an individual basis and within collaborative colonies of players. Features in the game are designed to appeal to different styles of play (adventure, exploration, hard and soft collaboration and competition, etc.) and tap into users’ varying motivations for both continued play in the game and continued physical activity outside the game.

Designing for (and with) an Urban After-School Program

Minority and low-income groups are even more at-risk for health and lifestyle chronic diseases than the general population (Calzada & Anderson-Worts, 2009; Skelton, Cook et al. 2009). Our team is working with an after-school program in a public middle school on the West Coast in a large urban area. The student population is 94% non-white, 41% limited English proficient, and 89% qualifying for free and reduced lunch, and the technology resources at the school and in students' homes are minimal. Home technology constraints are the main reason we sought out a device with an active display. Many wearable fitness devices are moving toward a zero-display model wherein visualization and information are offloaded to a Bluetooth smartphone application; however, the vast majority of our students do not own phones with this capability.

Results and Implications

Preliminary results indicate that the dual approach of monitoring activity via wearable devices and motivating activity via in-game rewards is highly promising. GET-UP students reported that they engaged in more frequent kinds of physical activities to "get more steps" than before they joined the project and received their fitbits, both recreationally and in terms of participating more during Physical Education (this was especially an issue for girls). Corroborating these claims with the database of fitbit syncs, we saw that most students' daily mileage did increase over their initial baseline (when they remembered to wear their devices, which was not every day).

So why is this approach unique? As youth wear their devices and play *Terra*, they are, in essence, gaming even when they are not gaming, and game-world activities are directly tied to their non-gaming choices and behaviors. In terms of identity, research on recreational gamers reveals that there exists an interesting dichotomy of user approaches, wherein users sometimes try to integrate aspects of their "real life" identities into the characters they play (Kafai, Cook, & Fields, 2010) and sometimes create alternative fantasy identities that are very different from themselves (Jenkins, 2006). In the GETUP program, player game data is directly tied to users' physical health characteristics, which may prove to motivate different kinds of learners differently. It may ultimately prove less motivating to those users in particular who value games for their escapist qualities. These issues around gaming, motivation, and identity—central concerns for the GET-UP project—as well as connections to players' physical bodies and physical health, have not been deeply investigated yet in the field.

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Qualitative methods for studying learning through gameplay at museums and science centers

Sarah Chu, University of Wisconsin-Madison, sarahnchu@gmail.com
Jason Yip, University of Maryland, College Park, jasonyip@umd.edu
Jason Haas, Massachusetts Institute of Technology, jhaas@mit.edu
Christine Roman, croman02@sbcglobal.net

Abstract: Due to the lack of research on games and learning in museums, there exists few established methods and strategies to best capture learning through gameplay in public informal learning environments. This makes research of this kind doubly complex given numerous other variables already to consider, particularly in acknowledging that learners at museums range broadly in age, gender, race and ethnicity, ability, and socio-economic status, along with their motivations for visiting in the first place. For our study at the Saint Louis Science Center, we observed player interaction with three games for learning science. In preparing for and conducting this study, we encountered several challenges unique to doing research in a public setting. We will draw from our experience running this study to highlight effective research methods for studying how people learn through gameplay in public informal learning environments.

Learning in Museums

Learning in museums can be measured in multiple ways, including capturing visitors' time on task, knowledge gain, thinking and problem solving, and motivation (Donald, 1991). Museum evaluators and researchers have taken up constructivist and sociocultural views of learning to understand visitors' meaning-making and knowledge development (Falk & Dierking, 2000). These views posit that learning is a cumulative and dynamic process influenced by visitors' prior knowledge, and that learning in museums in turn influences later developments in meaning-making. This, together with the fact that museums are free-choice institutions in which visitors may roam freely, makes conducting research on learning in museums complex (Falk, 2004). According to Falk (2004), research on learning in museums must consider numerous variables, particularly in acknowledging that the learners themselves range broadly in age, gender, race and ethnicity, ability, and socio-economic status, along with their motivations for visiting in the first place.

While there are few games in museums and fewer that exist permanently on exhibition floors, a handful of game-like interactives do currently exist in museums (Schaller, 2011). Good games can promote situated learning by providing opportunities for players to develop and practice skills in context (Gee, 2003; Shaffer, Squire, Halverson, & Gee, 2005). Similarly, science centers and museums embrace informal situated and experiential learning through play. As a result, we have begun to see more games installed at museums, including the Science Museum in London where an entire multi-floor wing is dedicated to digital interactive exhibits and games (Heath, vom Lehn, & Osborne, 2005). However, as the number of games in museums begins to grow, there remains a lack of scholarly research on them. Apostolellis (2010) echoes this sentiment, stating that there is still little understanding of how people play with games in museums and what learning outcomes such games produce. Due to the dearth of research on games and learning in museums, there also exists few established methods and strategies to best capture learning through gameplay in public informal learning environments, making research of this kind doubly complex given the previously mentioned variables.

Studying Games at the Saint Louis Science Center

For our study at the Saint Louis Science Center, we installed three games for learning science in the Cyberville gallery to observe the effectiveness and relevance of the games in a museum context. Over three peak days of one week, we documented visitor interaction (N=32) with the games through field observation notes, video recordings, and photographs. Additionally, we conducted a brief pre-game interview with visitors to determine both the experience they have had with games and museums, as well as their attitudes about games as tools for learning about science. Post-game interviews assessed how players have made sense of the science concepts presented in the games, including the depth and clarity of their understanding, as well as how they relate the games to other exhibits at the science center. These interviews also provided feedback about the games in regards to players' overall interest and appeal. As part of the study, we also ran a game design jam session at the St. Louis Public Library, where 14 children, teens, and adults spent two hours designing prototypes for the next big ideas on games in museums. Data from this session is used to triangulate our findings from the science center.

Our methods focused on 1) museum testing and evaluation; and 2) cooperative inquiry methods of design (Druin, 2002) using an intergenerational design group of children, parents, and researchers (Xie et al., 2012). While we based our methods of study on those typical of most qualitative user-centered research, we also encountered challenges unique to doing research in a public setting. From the IRB approval process, to recruiting visitors in the public space to participate in the study, to observing and interviewing the participants amidst the busyness of the museum, we overcame a handful of obstacles that would have barred the success of our data collection efforts. For instance, we noted that interviewing participants in a more secluded and quieter area of the museum, while still remaining on the exhibition floor (to be immersed in the context of study), would produce higher quality audio recordings of the interviews for later transcription and analysis. Discourse on methods for doing research in public settings is pertinent to all researchers who currently, or have intentions to, investigate how people learn in informal learning environments.

For our study in this public setting, one of our three games was installed on an iPad. In the post-game interviews, participants noted that displaying the game on a larger screen instead would have produced a greater invitation to other museum visitors both to watch and play. Participant interviews, along with our observations, suggest that mobile devices such as tablets and smart phones create a more intimate interaction that tends to hinder shared and collaborative experiences with others. In terms to data collection, the small screen size of the iPad caused difficulty for the researchers in observing and recording participants' gameplay. Future studies should consider videotaping play sessions using overhead cameras or, if the researchers have a hand in the game's development, incorporate data collection tools in the backend that log finger taps and swipes so researchers can better focus on in-museum observations.

This paper presents only a few of the preliminary findings from our study. Further analyses are planned in order to examine more deeply how people learn through gameplay in museums and science centers.

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College Quest: A Game-based LMS and Academic Social Network

Francesco Crocco, Joe Bisz, CUNY Borough of Manhattan Community College
fcrocco@bmcc.cuny.edu, jbisz@bmcc.cuny.edu

Abstract: College Quest (CQ) is a new web-based application that combines a robust learning management system (LMS) with a modern social network and popular game mechanics. Developed by faculty at the Borough of Manhattan Community College (BMCC) in conjunction with Neuronic Games and with support from a Federal Title V grant, CQ is designed to improve retention and success in online, hybrid, and web-enhanced courses by enhancing student engagement, organization, feedback, and collaboration. Research suggests games and social media can help institutions of higher education achieve these goals. A pilot study of CQ was conducted in the spring of 2013 at BMCC, and the results will be disseminated in subsequent papers and presentations.

Gamification and social media are becoming ubiquitous in online technology. Gartner estimates that 70% of Global 2000 businesses will manage at least one gamified application or system by 2014 (Burke, 2011) and Facebook, the top social media site, now reports 1 billion active monthly users (Facebook, 2013). Yet, major online educational platforms for higher education, such as Blackboard and Moodle, have been slow to incorporate these technologies. In the absence of alternatives, faculty at BMCC received funding from a Federal Title V grant to work with Neuronic Games to develop College Quest (CQ), a web-based learning management system (LMS) that integrates a social network and game mechanics in order to enhance student retention and performance in online, hybrid, and web-enhanced courses.

CQ provides user-friendly tools to create graphics-rich online courses with discussion forums, file storage, student to-do lists and notifications, outcomes-based real-time assessment, and a grade book. As a state-of-the-art social network, it offers students and faculty the ability to create public profiles (see Figure 1), message and friend users, create organizations, and identify possible peer mentors and collaborators. Finally, CQ incorporates game mechanics from commercial RPGs, such as customizable avatars, a point and level system for course work, skill-based badges, and a leader board.

Figure 1: Student

CQ addresses four areas of need in higher education: (1) engagement; (2) organization; (3) instant feedback; and (4) collaboration. Game-based learning and social media can meet these needs. Today's millennial students are "digital natives" who perform better in the multi-modal, feedback and reward-laden environments provided by video games (Prensky, 2001). Additionally, studies show social media appeals to specific learning needs of Millennials (Papp, 2010).

Games are adept at enhancing engagement and organization. For instance, Massively Multiplayer Online Role-playing Games (MMORPGs) promote intrinsic motivation with built-in achievement systems (Kenny & Gunter, 2008; Dickey, 2007) and enhance player identification through the use of avatars (Waggoner, 2009; Murphy, 2011). The quest-based systems built into MMORPGs and game-based schools like Quest to Learn also help to support organizational skills and well-ordered problem solving. Yet, the virtual learning environments currently available either are not designed for higher education (e.g., Second Life, World of Warcraft, and Quest Atlantis) or lack essential LMS components, such as discussion forums (e.g., 3D GameLab). CQ specifically targets engagement with game-based features like customizable avatars, a point-and-level system for course work, and outcomes-based badges; it also organizes student work with an assignment-based to-do list and notification system.

Successful video games also feature instant feedback loops (Gee, 2007) in which players receive a constant flow of information about specific skills in the context of play and interpret it to improve performance. Studies find that embedded assessment and constant feedback can significantly improve learning (Gijbels et al, 2005). CQ is designed to provide students with outcomes-based assessment on each assignment, thereby situating the meanings of assessment more clearly so that students can self-evaluate more effectively. Studies of formative feedback in education support the educational potential of this design by showing that feedback is most beneficial when "highly related to clearly identified learning goals" so that feedback is "not only based on monitoring progress toward the specific goals but also promotes students to develop effective learning strategies" (Gikandi et al, 2007). Game-based embedded feedback may have much to offer online and blended learning classes in particular, where "meaningful interaction" is sometimes difficult (Gikandi et al, 2007; Akyol et al, 2009).

Games and social media also enhance collaboration. Social media facilitates peer review (Bassford & Ivins, 2010) and, when integrated with games, encourages collaborative learning (de Freitas & Griffiths, 2007; Choi et al, 2007). The importance of integrating a social network within an LMS is demonstrated by a survey performed at BMCC in which 37.8% of students stated that a "major reason" they would use an educational game is if it were part of a college social network (BMCC, 2011). Accordingly, CQ provides a messaging system that enables users to communicate, identify mentors and collaborators, and create online spaces to form affinity groups.

CQ underwent a pilot study in spring of 2013 at BMCC to evaluate how well it meets the four high priority needs of engagement, organization, feedback, and collaboration. The results of this study will be released in subsequent papers and reports. If successful, the software's innovative blend of LMS, game design, and social media will help to advance online learning technologies for higher education.

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Leveraging Play to Promote Sustained Health Behavior Change

Shree Durga, Magy Seif El-Nasr, Mariya Shiyko, Carmen Sceppa, Pamela Naab, Northeastern University
sh.subramanian@neu.edu, m.seifel-nasr@neu.edu, M.Shiyko@neu.edu, C.Sceppa@neu.edu, naab.p@husky.neu.edu

Abstract: Long-term health outcomes, such as obesity and diabetes are particularly challenging to manage because they require regimented behavioral changes impacting day-to-day living for a sustained amount of time. While short-term interventions remain unsustainable for the most part, games and ubiquitous health-based technologies can play a crucial role in incentivizing healthy eating and exercise behaviors in day-to-day routine and potentially motivate players to adopt some of these small behavior changes in their lives. In this poster, we present the core design and play mechanics of a health-based social media and game environment that is designed to encourage healthy eating and exercise behaviors in players.

Games and Health: Opportunities and Challenges

Rising trends in obesity and obesity-related health risks have persisted for over two decades, in the US, and over 50% of adult population do not meet even the rudimentary federal recommendations for aerobic activity or muscle strengthening (CDC, 2011). Moreover, increasing evidence from research in health and behavioral sciences suggests that longitudinal health outcomes, like obesity result from persistent unhealthy dietary choices and sedentary living, and thus, ought be managed through sustainable modifications to everyday eating and exercising behaviors (Hung, et.al., 2007;). However, longitudinal health behavior change, particularly related to chronic ailments, such as obesity, is a complex process, often affected by individuals' motivation to change, impact of constant external feedback and monitoring systems that can help individuals to track long-term goals (Consolvo, et.al., 2009). Considering the reach and popularity of health-based ubiquitous technologies — a recent Pew's survey reports that the number of people using smartphones to manage or track personal health went up up from 9% in 2010 to 29% in 2011 (Smith, 2011) — games can be compelling motivators to incentivize health behavior change. In this short paper, we briefly describe the core design mechanics of the game *Spa Play™*— a game designed to motivate players to adopt healthy eating and exercising behaviors. The game was developed using motivational strategies based upon *gamification* techniques, such as reward systems, player autonomy to set and monitor goals, sensor-tracking and prompting (Paramythis, et.al., 2010; Consolvo, et.al., 2009;). Findings from early pilot of the game indicate that the motivational tactics in the current iteration of the game work well, but also allude to some shortcomings that are to be modified to improve players' adherence (Durga, et.al., 2013). We will overview some of these preliminary findings about player acceptance of the game and chart out future directions for our work. We seek to test and validate the use of these techniques as motivational tactics, specifically to measure player adherence and retention.

Spa Play™: The Game and Core Design Principles

Spa Play™ (Figure -1) is an online health-based social media and game platform, in which players maintain a virtual island and a health spa. In order to maintain and increase spa rating, players need to do certain island-related routine activities (e.g., cleaning the running tracks, harvesting fruits from trees, unlocking the facilities, etc.). In addition, players accrue points to unlock game content by doing real-life activities related to exercise and healthy eating required by *sparks* and *quests* in the game. *Sparks* can be thought of as real-time actions in a game that entail doing short-burst gaming activities some that are related to exercise, eating and drinking, while some that are in the game world, such as solving a word puzzle. The design intent was to encourage players to develop fondness towards some of the play mechanics, in short bursts, while adding playfulness to ordinary or day-to-day physical activities, such as *walking till the next bus stop* or *taking an extra flight of stairs*. *Quests*, on the other hand, are a thematic grouping of several tasks that typically take somewhere from a few days to a week to be completed. Example quests include, beginner training for biking, or planning a healthy meal outside with your friend. Quests take longer than sparks to complete, while they also reward more experience points. Players can track progress of their quests. In short, both sparks and quests are recurrent, repetitive activities that reward players with experience points to unlock new content for the island improving the aesthetics of the resort and its rating. Upon logging in to the game, the game shows interesting statistics relevant to player activity and progress in the game, such as showing how many sparks and quests they did the past week, each day, done recently, and so on so forth. The game is designed to motivate players to track what they did in the game (Consolvo, et.al., 2009;), while creating an appealing and persistent space (the island) for players to spend time in, maintain it and improve its aesthetics and rating.

Figure 1: From left-to-right—virtual island in the game, *sparks* and player avatar motion in response to real-life pedometer activity

In February of 2013, an early pilot of Spa Play was conducted with 18 participants. In terms of design and game mechanics, our findings indicate that players were able to relate to most of the sparks and quests in the game. 18 participants completed a total of 505 quests during the 45-day length of the study. Of those quests, 19.8% were food-related, 40% were physical activity-related, and 40.19% were game-related (e.g. “harvest bananas”, “clean up the island”). Similarly, of the 3,697 completed sparks, 43.68% were food-related and 56.3% were physical activity-related. From the design perspective, we found that recurrent activities related to the aesthetics of the island or the spa (e.g., keeping the resort clean, harvesting bananas, visiting the yoga studio, finding and visiting the community lounge) were successful motivators, and players felt compelled to login to the game on a regular basis to maintain the resort rating.

Conclusions and Implications for Future Work

Through our design process and early pilot of the game we identified several important themes that needed further development. One of the salient observations from the pilot was that after a couple of weeks into the game, players tended to settle on and repeat regularly a limited set of quests and spark activities (Durga et al., 2013). As such, the current version of the game had limited impact on how much it could push players to go beyond a certain set of *sparks* and *quests*. It does become apparent that in design of games that attempt to incentivize recurrent health behaviors, player adherence is affected by how well the content of the game blends with the daily fabric of participants’ lives (Durga, et.al., 2013). For our next iteration, thus, we seek to incorporate and empirically validate adaptive messaging to populate profile-based game content. In broader terms, the ongoing work carries a significant potential to develop a portable, inexpensive and effective tool for addressing chronic weight gain and to impact the field of “games for health” by developing a new set of methodological tools for assessing real-time effectiveness of games and gamification techniques.

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The Cognition of Gameplay: Cognitive Task Analysis and Portal 2

Patrick Gallagher, Shenan Prestwich, Advanced Distributed Learning, Alexandria, VA, USA
shane.gallagher.ctr@adlnet.gov, shenan.prestwich.ctr@adlnet.gov

Abstract: Cognitive task analysis, though widely used in industry and education to analyze the cognition of task performance as well as parse out learning requirements, has not been applied to analyze the cognitive requirements of expert game performance or create a cognitive map of a game. ADL researchers have developed a novel methodology for applying CTA to gameplay in order to analyze video game design and video gamer cognition within a particular game.

Background

To better understand how video games can be leveraged for learning, the ADL Next Generation Learner Team recently studied the effects of playing a game with certain design characteristics, and of amount of game play experience in general, on cognitive adaptability, a skill that involves responding to uncertainty and to changing circumstances and monitoring one's own thinking processes. The study used Portal 2, a game developed by Valve Software, for its perceived inclusion of the five design characteristics (implicit rule sets; implicit shifting of rules; dynamic, shifting environments; implicit reinforcement of actions to achieve a goal; and relatively open-ended gameplay) proposed to help improve cognitive adaptability. A preliminary literature search revealed a void of research throughout the fields of gaming, education, and cognitive psychology on the specific effects of game design principles on cognitive adaptability, so these five characteristics were extrapolated from research findings in the fields of clinical psychology (specifically cognitive remediation therapy for improving cognitive flexibility; Delahunty, Reeder, Wykes, Newton, & Morice, 1999; Wykes & Reader, 2005; Wykes, Reeder, Landau, Everitt, Knapp, Patel, & Romeo, 2007), feature overlap theory (Halpern, Hansen, & Riefer, 1990), and existing research on cognitive adaptability in order to take existing theoretical and practical efforts to foster cognitive adaptability and translate them into game design features. As a result, the following questions emerged: how does one understand empirically whether Portal 2's design really fits those five characteristics, and is it possible to capture the thought process of an expert gamer as they make their way through a game and map out, scientifically, exactly what it takes to conquer a game like Portal 2?

Cognitive Task Analysis

Cognitive task analysis is a technique that has traditionally been used by researchers and industry professionals to capture both the behavioral and cognitive processes and activities that go into accomplishing a task at an expert-level. This includes decision-making processes, recognizing and responding to critical cues, responding to environmental conditions, utilizing tools, performing smaller sub-tasks, and analyzing and altering one's own performance (Clark, Feldon, van Merrienboer, Yates, & Early, 2006; Cooke, 1994; Militello & Hutton, 1998; Wei & Salvendy, 2004). While CTA has been applied to educational game design in some ways, such as Boyle et al.'s (2012) study which utilized CTA to aid in the design of a digital game to support research and statistics education, very little cognitive task research has been done on the cognitive and behavioral performances of expert gamers or the cognitive requirements of existing games. As precedents for this kind of analysis did not emerge from the literature on industrial/organizational psychology, cognitive psychology, or gaming, the ADL team prototyped a protocol for performing a CTA to analyze video game design and video gamer cognition within a particular game. Drawing on established CTA literature as well as exploration, the team produced a method for cognitively mapping the design and cognitive/behavioral requirements of gameplay.

Cognitive Task Analysis and Video Games: Current Research

The group leading the CTA effort has been observing expert Portal 2 players—those who have played through the entire game multiple times—playing through each chapter and level in the game. Through a combination of real-time narration of the players' actions and thoughts throughout gameplay and after-action interviews after each level where the player and the researchers review a recording of the gameplay made using FRAPS video capture software as well as independent audio recordings, the researchers are mapping out a clear cognitive and functional picture of each level. This includes painting a complete cognitive map and decision matrix of each level of the game by determining what affordances (objects, tools, and environmental features that the player has to interact in order to achieve the final goal) and micro-puzzles (smaller puzzles that need to be solved in order to achieve the larger puzzle of the overarching goal) are present in each level, as well as what manual steps (e.g., walking down a hallway, shooting a portal, pressing a button, moving an object, etc), cognitive steps (e.g., taking note of visual and audio cues, making decisions, inferring or deducing things from events or information in the game, etc), and prerequisite and requisite knowledge are required in order to complete the level.

Additionally, after each level, a post-play interview is conducted to examine the presence or absence of the five design features posited to foster cognitive adaptability: implicit rule sets, implicit shifting of rules, dynamic and shifting environments, some degree of open-ended gameplay, and implicit reinforcement for individual actions to achieve a final goal. During this interview, the player is asked to describe what rules (constituative or operational) are present and if, how, and where they've changed from previous levels; what new or altered environmental features arise; what feedback or cues informed the player's decisions (whether implicitly or explicitly); and what, if any, constraints to gameplay the player perceived. Player feedback in this regard is then analyzed to pinpoint the presence of the five game design characteristics thought to influence adaptability in thinking, as well as the qualitative decision making required to work through them. The rubric of design characteristics is thus used in conjunction with the cognitive- and task-mapping focused questions to examine further where these five design tenets present themselves within Portal 2 and subsequently influence player cognition during gameplay.

Goals

By performing a CTA on Portal 2, ADL researchers hope they will be able to pinpoint both what expert performance looks like cognitively, establish a baseline of the intersection design features and cognitive adaptability design tenets, and understand how the game's design features influence player cognition during gameplay. This is essential for assessing the cognitive impact of gameplay and game design, a key component of the growing effort to leverage games for educational purposes. The undertaking is also producing a novel framework for and approach to using cognitive task analysis to harness the potential of video games for improving learning and cognition.

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Producing Educational Mini Games: A Worked Example of the Agile Production Approach

Gabrielle Garner, The University of Georgia, ggarner@uga.edu

Abstract: This worked example is based upon empirical evidence drawn from a two-year ethnographic study of the ways in which sociological, economic, and technological manifestations of culture influenced the production of educational computer games within a large entertainment company. Primary data sources included 22 individual interviews, field notes, internal documentation, photographs, sketches, digital prototypes, and written correspondence related to the team's process for creating a large collection of mini games, designed for a popular massively multiplayer online game for children. Within this corporate system of innovation, core workforce competencies included the abilities to continually innovate, learn, and adapt under what team members collectively perceived as challenging conditions. This essay is an invitation to consider the ways in which the Agile production approach supported the continued development and maintenance of these competencies among team members within the context of educational game design and development.

Introduction

This essay explains some of the ways in which the Agile production approach influenced the process of creating a collection of over fifty educational computer games (Garner, 2011). First, the general principles of the approach will be described. Second, the use of these principles will be explained as they were observed over the course of a two-year empirical study.

Applying the Agile Philosophy

When applied in relevant development contexts, principles of the Agile philosophy were intended to serve as general guidelines for the strategic development of systems of technology and human organization (Hobday & Brady, 2000). Shaping many of the ways in which team members collaborate with each other and with clients, Scrum is a production approach that is rooted in the Agile philosophy and was designed to engage design teams in a highly productive and fundamentally human process of product development in consideration of the following culturally, professionally situated condition:

> The people developing software all have different skills, intelligence levels, experience, viewpoints, attitudes and prejudices. Everyone wakes up in a different mood than the day before, depending on his or her sleep, health, weather, neighbors, and families. These people then start to work together, and the complexity level goes through the roof. (Schwaber, 2004, p.5)

Grounded in empirical process control theory, "the role of Scrum is to surface the relative efficacy of your development practices so that you can improve upon them, while providing a framework within which complex products can be developed" (Schwaber & Sutherland, 2008).

The Worked Scrum

Shaping many of the ways in which team members collaborated with each other and with clients, Scrum was designed to engage design teams in a highly productive and fundamentally human process of product development. Based on the Scrum framework, some combination of the team, scrum master, and product owner would begin production by conducting a Release Planning Meeting in which they answered the questions, "How can we turn the vision into a winning product in the best possible way? How can we meet or exceed the desired customer satisfaction and Return on Investment?" During the Release Planning Meeting, the team established the probable delivery date, costs, major risks, and overall features and functionality of the release.

In consecutive two-week periods, or sprints, the team consistently achieved its release goals. During each sprint, team members completed concretely defined projects, including what is to be built, the plan for building it, the actual work completed according to plan, and a resultant product. Game designers and developers were the only team members directly involved in and accountable for the release deliverables defined in each sprint. During each sprint, daily scrum meetings occurred in the same place and at the same time each day. The scrum master enforced a strict fifteen-minute time limit. The purpose of the daily meeting was to inspect the team's progress toward the sprint goal and facilitate all necessary adaptations, based on the empirical inspection. Each team member explained (a) what he or she had accomplished since the last meeting, (b) what he or she was going to do before the next meeting, and (c) what obstacles were in his or her way.

At the end of each sprint and before the start of the upcoming sprint, the team presented the product's functionality to stakeholders, clarifying and answering questions about what was done, during the Sprint Review Meeting. Each product owner identified what had or had not been done, and the team discussed problems that arose, the ways in which problems would or should be dealt with, and what went well during the previous sprint. The purpose of the Sprint Retrospective Meeting was to inspect how the ending sprint went in regards to people, relationships, process, and tools; to identify and prioritize major items that went while and those items that, if done differently, could make things even better; and adapt to empirical inspection by identifying actionable improvement measures to be implemented in the upcoming sprint.

During the Sprint Planning Meeting, the team defined its goals for the upcoming sprint and collectively figured out how it would build functionality into a product increment during the sprint. Others were also invited to attend the Sprint Planning Meeting in order to provide technical or domain advice.

Discussion

The most powerful effect of the scrum process was that the team was able to generate a high quantity of games in a relatively short period of time (Garner, 2011). The more subtle, but equally important effect was that the process made visible each team member's strengths, weaknesses, progress, lack of progress, and needs, allowing leaders to give them the proper resources support needed to succeed in achieving their goal of satisfying the stakeholders. In the event of individual failures, the retrospective meeting provided the time and place for proper reflection and resolution among all team members. At minimum, the practice of scrum organized the team's production activities and standardized the practices of constant inspection and tracking of progress. The process empowered team members to take ownership of their own products and tasks, leading to a much more positive work experience and environment. Leaders' application of the Agile philosophy optimized team performance, reinforcing the argument that Agile approaches can be effective and useful when engaging in the design and development of educational games in corporate and non-corporate settings.

Next Steps

Because of an educational game's complex design constraint, that the final product must at once teach something and be played, the influence of educational game development *procedures* on the design strategy and quality of the outcome must also be further explained. The lived experience of the team members must also be described, as well as, the extent to which this process influenced team members' abilities to continually innovate, learn, and adapt in the complex corporate environment.

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Digital Badges for Recognizing, Assessing, Motivating, and Evaluating Learning in Games and Beyond

Daniel Hickey, Rebecca Itow, Andrea Rehak, Indiana University
Katarina Schenke, Cathy Tran, University of California Irvine
dthickey@indiana.edu, rcitow@indiana.edu, amstrack@indiana.edu, katerinaschenke@gmail.com, ctran27@gmail.com

Abstract: Digital badges are web-based tokens of accomplishment and learning. Thanks the 2012 MacArthur/Gates *Badges for Lifelong Learning* initiative*,* hundreds of formal and informal programs are now incorporating digital badges. The *Design Principles Documentation Project* is capturing the knowledge being generated by thirty diverse programs that were directly funded by the initiative to develop digital badges. This poster will present the design principles for using digital badges for recognizing, assessing, motivating, and evaluating learning. Visitors will get a seek-peek at the now-private project database that is organized around the 5-7 general principles that have emerged in each of the four areas. Each principle is accompanied by a burgeoning database of the relevant research literature and illustrations of how that principle has been enacted in specific projects.

Digital badges are web-based tokens of accomplishment and learning that promise a new and transformative way of recognizing and credentialing learning and accomplishment. The MacArthur/Gates Badges for Lifelong Learning initiative attracted over 300 proposals in the 2012 competition. Thirty awardees for developing badges and content were paired with several awardees for developing platforms and issuing badges. This laid the groundwork for a new ecosystem for recognizing learning as partners work together within Mozilla's Open Badge Infrastructure (OBI) to implement their plans. The awardees represent a diverse range of programs, from very traditional (Girl Scouts and 4H) to cutting edge (*BuzzMath* videogames and *MOUSE Wins!* for national youth technology leadership). But the competition and the unfolding initiative allowed the technology, standards, and participants that define this new ecosystem to emerge in just a few months. The existing accreditation system of grades, degrees, and transcripts took roughly a century to develop. We are witnessing the deliberate and rapid creation of something that might transform a significant piece of the educational landscape.

The Design Principles Documentation Project

The DML Design Principles Database project aims to capture the most useful knowledge being generated in this initiative. As awardees attempt to enact the plans outlined in their proposals, they are discovering both challenges and opportunities. Mozilla's Carla Casilli explained this process in a 2012 blog post:

> Regardless of where you start, it's more than likely you'll end up somewhere other than your intended destination. That's okay. Systems are living things, and your badge system needs to be flexible. You must embrace a bit of chaos in its design.

As shown in more systematic studies of software architecture design rationale (e.g., Krutchen, 2004), most of the knowledge generated when designing complex systems simply "evaporates" as features evolve and teams dissolve. Our project aims to capture this knowledge as it is being generated, sift it for the most generally useful ideas, link those ideas to the contextual factors that framed their appropriateness, share this knowledge widely, and lay the groundwork for continued refinement.

Like digital badges, this is uncharted territory. The closest example is the Design Principles Database project (Kali, 2006). That project also captured design knowledge across multiple projects and helped share that knowledge. To do so, they distinguished between (1) specific *practices* within projects, (2) specific project *features* used to enact those practices, and (3) more general design *principles* that captured those practices and features across projects. The Design Principles Documentation project is organized around these distinctions as well. Specifically, the project is identifying the more general design principles that emerge across the various projects. The design principles are then illustrated with practices and features from specific projects, and elaborated with a database of the relevant research literature. Thus, rather than searching for mythical "best practices" the project is identifying "appropriate practices along with the contextual factors that others need to help use and refine those practices in their own contexts. Drawing from studies of media "spreadability" (Jenkins, Ford, & Green, 2012) we are supporting spread and continued transformation of knowledge. We are doing so by deliberately fostering networked communities of practice (Wenger, McDermott, & Snyder, 2007) around this knowledge.

In order to foster coherence, community, and spreadability, this project is organized around badge *functions.* Focusing on actual functions (rather than intended *purposes*) highlights the way that educational practice often function in unintended ways, and that functions interact with each other in complex ways. After some consideration, the project was organized around the following four functions: *Recognition* is the most obvious and arguably the primary function of badges. At their core, all badges are used to recognize some learning or accomplishment. *Assessment* is almost always called for when learning gets recognized. Most assessments serve both summative and formative functions. In some cases these are simply an assessment of whether somebody clicked on a few things or made a few comments. In other cases there might be a project or essay that was reviewed and scored, or a test that was graded. *Motivation* is the most controversial function. Much of the debate over badges concerns the well-document negative consequences of extrinsic incentive on intrinsic motivation and free choice engagement. This is why some argue that we should not use badges to motivate learning. However, if we use badges to recognize and assess learning, they are likely to impact motivation. Because many uses of badges offer new power and privilege, they seem less likely to disempower learners. Regardless, this needs to be examined systematically *Evaluation* is the least explored function of badges. Digital badges have tremendous potential for helping teachers, schools, and programs evaluate and study learning. At the minimum, just having a system for tracking all of the information include in all of the badges that a program awards might be very valuable. Each badge has eight bits of information ("metadata") which will be recorded and easily accessible as a database. And much of that information will be hyperlinked to even more information that will be accessible with just a little more effort.

Methods

Starting in 2012, the project first created a database that summarized the intended practices for using digital badges. Interviews with representatives of the various projects were conducted in late 2012 and early 2013. These interviews focused on the ways that the intended practices were being enacted in the various project contexts. Particular attention was directed at how the various project contexts shape their enacted practices. In Spring 2013, projects are reviewing and validating the characterization of their intended and enacted practices, while the project is beginning to identify 5-7 design principles in each category, along with the research literature that is most relevant to each. The conference poster will present the design principles and the relevant research and example practices and features for each. Visitors will be allowed to access the project database and examine the design principles, relevant literature, and examine practices and features of projects that have approved their project representations for viewing by the public.

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Visual Analysis Toolkit: Four Use Cases

Jeff Holmes, Alex Cope, Rebecca Hoffman, Ben Pincus, Jesse Shedd, Arizona State University
jeff.holmes@asu.edu, aecope@asu.edu, rebecca.hoffman@asu.edu, benjamin.pincus@asu.edu, jbshedd@asu.edu

Abstract: This poster provides four visual analyses of videogames with a focus on the structures of semiotic resources based on tools developed by the Authors in order to establish a methodology for exploring how we create meaning around the practice of gaming. Using several perspectives, including the relationship between "noticings" and orientational elements, visual conventions within and beyond games, and ideological frameworks to explore various videogames, this poster both uses the visual analysis tools as well as critiques the applicability of these tools to further an emerging discussion about how we create and share meaning in and around videogames.

Using the visual analysis toolkit also included in these proceedings (Holmes, 2013), this paper provides four use cases that demonstrate a variety of applications and frames for conducting visual analysis around videogames. These frames include the orientational elements and "noticings", structures and conventions of games and other media, and ideological lenses. By providing multiple applications of the tools, we seek to both utilize and refine these approaches across different genres and use environments. For designers, understanding the various conceptual conventions and semiotic resources available to them can help drive more effective design. For players, understanding the ways in which designers intend meaning as well as the ideological frameworks they bring to a game enables a deeper interrogation of their play and a stronger reflection on the choices they make and the actions they perform in their play. Meaning making occurs across many modes, from kinesthetic feedback to textual interfaces to aural cues to the mechanics of the game itself. As a dominantly visual medium, however, videogames offer a particularly rich space for discussing the various methods for creating and negotiating meaning. Creating a more robust framework for analyzing the resources used to make sense of the game and how these prepare players for the actions of play opens new avenues of analysis and critique as well as new discussions on how to best create and experience games more broadly. Finally, limiting this analysis to visual semiotics both focuses the research and provides insight into an as-yet underserved area of research and application.

Use Case 1: Point of view and salience as structural elements in *Shadow of the Colossus*

This use case explores the structures and conventions of point-of-view and salience in *Shadow of the Colossus*. These features help orient the player to the game and the interfaces, instruct and guide them in engaging with the mechanics of the game, as well as point to the larger narrative and ideological frames. The game employs a third-person perspective that shifts based on the context of the current actions; scaling the massive colossi often centers the camera not on the player but on the colossi themselves, and pulls the camera back to a "far distant" view; when the player aims their bow the camera shifts to an over-the-shoulder view and close distance. This changing view ties directly to what the player is doing (climbing the colossus, shooting their bow) and helps accommodate those actions. It also demonstrates the scale of the colossi in contrast to the increasingly small and hapless player-character, tying the player to the story of the game and the ethics of your actions. Salience—how elements are foregrounded or backgrounded—similarly supports both a player's actions and the stories of the world. Elements of the interface, light and shadow, color, and size all work to direct the player's attention to objects to interact with and actions to take. They also point towards what is important or necessary to understand about the gameworld itself. Together, these structural elements help players know how to play the game as well as how to frame the contexts of their actions within the game's narrative conceit.

Use Case 2: Color as a videogame convention

Color palettes are an integral aspect of aesthetic, narrative tone, and audience positioning across media types. In games, color also helps players recognize not just how to feel and but also how to act. This use case examines color in *BioShock Infinite* (2013), *Dishonored* (2012), and *Dear Esther* (2012) to first assess the semiotics of color as a convention unique to videogames, drawing on Kress and Leeuwen (2002), and then to critique games against color conventions of mainstream media and advertising. By assessing color in terms of its use in games as a unique convention, this use case further focuses on color as an important factor in determining player action, where particular tones and palette choices can help users assess their position and status in the gameworld (e.g. 'safe' versus 'in danger') as well as the ideological framework of the gameworld and narrative (e.g. 'good' versus ‘bad’). The strength of color to convey and inspire these emotions and actions provides a growing space for developers to experiment with the juxtaposition of color and ideology as a means of inspiring complex emotions in the player (such as betrayal, fear, or victory) by affirming, reifying or subverting common game-based color conventions.

Use Case 3: Designer choices and ideological frames in *Game Dev Tycoon*

The visual analysis toolkit provides one methodology for examining a designer’s ideological frames by focusing on the choices they made in creating and using visual representations within the game. This analysis uses *Game Dev Tycoon* (2013) to understand the designer’s ideological claim about how games are made and what effects piracy has on that practice, with an emphasis on the differences between a legitimately purchased version of the game and a pirated copy (which the developers distributed themselves). Making a profit is a central premise of the game. Representational cues highlight this premise: widgets appear on the right-hand side which shows cash on-hand, cashflow and sales, promotions and other economic metrics. Other menu items like hiring employees and game updates also demonstrate this ethic; so does the progress of the player’s company, which expands its physical space and its staff. The pirated copy of the game includes mechanical penalties like low cashflow and prevents the player from “beating” the game; it also indicates to players that their fictional game is suffering due to high piracy rates. The designers could have chosen to simply put a message at the beginning of the game to express their disapproval of the game piracy practice, but according to designer Patrick Klug (2013), they “didn’t want to pass up the unique opportunity of holding a mirror in front of them and showing them what piracy can do to game developers”. These representational choices illustrate the worldview of the game’s makers and indicate their assumptions about the game development industry.

Use Case 4: Outside the game representations and preparation for action

Applying the visual analysis toolkit beyond the on-screen representations to include “gaming adjacent” representations like marketing materials and other media provides insight into the relationship between representation and play. This use case examines the box art of several Mario games, which almost invariably demonstrate the new tools and significant changes to the game space. These changes occur over time between generations of hardware and across other Mario games. The box art can be seen as a way to “prime” players for the different experience and different mechanics offered in each game. The box art generally depicts Mario with a new ability he will have during that game. For example, *Super Mario Brothers* (1985) shows him with the fire flower power up (a new ability for Mario from his previous incarnations); *Super Mario World* (1990) shows him riding Yoshi wearing a cape (both a new character as well as a new ability); *Super Mario 64* (1996) shows him flying with the Wing Cap (another new tool), and *Super Mario Sunshine* (2002) shows him with the water backpack, F.L.U.D.D. Showing the player the tools of Mario uses in the particular game on the box art orients the player to what mechanics are new in the game and what is available to them to complete the characters goals. Similarly, the box art often tells the player how Mario’s world changed from game to game. For example, the change from a 2D to the 3D space is depicted in *Super Mario 64* by the emphasis on the depth of the 3D world and Mario flying over the title of the game. The world is generally only represented on the box art when the world itself changes; otherwise, the focus is almost exclusively on the character of Mario. This use case primarily shows how representations can prepare players to play and make sense of the context for their play.

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How to Look at Videogames: A Visual Analysis Toolkit

Jeff Holmes, Arizona State University, Tempe AZ, jeff.holmes@asu.edu

Abstract: A language for understanding how meaning is made in and around videogames in their various forms is critical for both designers and players. For designers, understanding the various conceptual conventions and semiotic resources available to them can help drive more effective design. For players, understanding the ways in which designers intend meaning as well as the ideological frameworks they bring to a game enables a deeper interrogation of their play and a stronger reflective practice. This paper presents a three-tiered framework for visual semiotic analysis: representational/orientational elements, structures and conventions, and ideologies.

This paper provides a methodology for analyzing the visual elements of videogames, and in particular how those elements can help players understand the contexts of the game and prepare them to act within it. Visual elements help orient players to the mechanics of the game (what they do) and to the stories they enact (why they are doing it and how). There is a risk in isolating visual elements from other modes of meaning-making in games, as gameplay is about how these modes work together to make the meaning of the game possible. However, this analysis considers how the visual elements point towards these other modes, how the game cues players in how to interpret and act, and how to use the visual features to "do" the game. Building on a framework developed by Serafini (2010), this methodology for visual analysis looks across several interrelated features: the representational and orientational elements within the game screen; structures and conventions called upon; and ideological choices and frames used by the designers in creating the game and by players when interpreting and enacting that design. If, as Serafini suggests, we think of these as nested layers within a sphere, then the outermost level is the ideological frame, the middle is the structural and conventional frame, and the innermost is the representational elements or "noticings"; we look inward through ideologies, through conventions, at the "noticings," which reflect back to us those other features. It is important to understand that the boundaries between layers is porous; conventions are certainly ideologically motivated; color is both a semiotic structure (Kress and van Leeuwen, 2002) as well as a noticeable element. These features blend into each other and isolating them is useful only in the most abstract deconstruction. In the everyday world players experience these things simultaneously and as compound meaning-potentials.

The work of meaning: Orientation and Preparation

Gameplay is about the mechanics of play, about the specific tasks and actions, the inputs and outputs, the systems that govern those interactions, win states and status states and more. Games are also about new worlds and new identities, ideas and stories, narrative tales and player enacted happenings (Gee, 2003). They are both tools *and* stories. Some games focus on one feature more than the other; they are all videogames though they may present their tools and stories differently. Visual elements must help orient players to the game space and to the tools of the game; they must help players come to some understanding about what they are supposed to do and how to do it. In this way, these visual elements also "prime" players to act effectively and continue the game. These cues can be geared towards the mechanics of the game (icons indicating actions, highlighting key elements, textual cues), or cues into what the player should believe (the narrative they are participants in, what mood or feeling the game is portraying, what ethical or moral beliefs make up the world itself). It is important to recognize that these visual elements are moving and changing throughout gameplay; games may intersperse cutscenes, menus, action sequences, text and more in a dynamic way. Playing the game involves navigating a shifting nexus of representational elements over time. Specific examples and use cases of the tools described below are included separately in these proceedings (Holmes et al., 2013)

Analysis Tool #1: Representational/Orientational noticings

The representational/orientational elements of games help players make sense of what the world is and what they should do. These elements are things like the buttons and labels on the screen, the avatar and characters, the world or space players inhabit, textual elements, colors and shapes. Noticings also include tone, what characters and other objects looks like, what fills out the world, and what colors are present. These elements point to the conventions the designers chose to make the meaning-potentials of the elements and help indicate the ideological beliefs they used to design the game.

NOTICINGS TOOL: What do you notice? What stands out to you? What seems important? What indicates how you are supposed to act in the game? What tells you about the story or world you inhabit? What features are part *of the interface? What features are part of the "story"? How are these related? How do they influence how you act in the game?*

Analysis Tool #2: Structures and conventions

Structures refer to the composition of the representational/orientational elements, including color, size and placement, salience, framing and emphasis, point-of-view, and others (Kress and van Leewuen, 1996). Conventions refer to the ways these structures are used to promote particular meanings and how various visual elements are used across different games, different genres, and different media. Structures and conventions work in similar ways. The color palette of the game, for example, provides cues to the content and the actions of the game (e.g. a bright cheerful color usually indicates safety or peacefulness, a dark color scheme often indicates danger, and thus how a player might expect to act). Perspective and point-of-view often tell players how they will play (first-person games are often shooters; detached, distant perspectives are often utilized by RTS or puzzle games). They also help orient players to the story elements of the game (players are the character in a first-person game, while characters in RTS games are oriented more as tools to be used). Features like salience and framing help players understand what is important and what is worth noticing, and what these things might mean within the larger gameworld.

STRUCTURES AND CONVENTIONS TOOL: How are the elements arranged? How are they related to each other? What is emphasized, and how? What is the color palette of the game? What does this indicate to you? What is the point-of-view of the game, and how do you relate to the game through this perspective? How are these elements represented in other games? How does that influence how you understand them, and act in the game? How are these elements presented outside of the game? Does the game conform to these extra-game conventions or does it challenge them?

Analysis Tool #3: Ideologies

Ideologies refer both to the worldviews and beliefs of the designers when creating the game (and how they choose to represent them) as well as the worldviews and beliefs of the player as they play (which informs what they notice and how they interpret it). This frame provides players and designers a chance to reflect on what they believe about the gameworld and how they want to act within it. Ideologies are manifest both in the representational elements (what things look like, why those appearances and not different ones, what is included or excluded) as well as the mechanics of play (do players shoot and kill things, do they organize and arrange things, is conflict a driving motivation, or is resolution and so on).

IDEOLOGICAL TOOL: What are the values and ethics promoted by the game? How are these manifest in the representational elements? What elements are present (or absent) which inform your interpretation? What do you believe about the world? Does this match or conflict with what the game is "about"? How do these beliefs drive you to act within the game?

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Engagement, Understanding, and Achievement: Iterative Assessment and Refinement of Khipu Master

Ellen Jameson, Dr. Daniel T. Hickey, Indiana University Bloomington,
ejameson@indiana.edu, dthickey@indiana.edu

Abstract: We designed the Khipu Master game to support several 5th grade Common Core mathematics standards related to the base-10 number system. Taking the design from its starting point, we are using design-based research methods to refine both the design and the assessment instruments through a series of iterations. We have finished conducting a pilot study on basic elements of the game and a feasibility study on the first iteration, and are in the middle of collecting data for a comparison study on the second iteration. So far, gains on the pre/post assessment appear to have increased modestly after the first iteration.

Introduction

In the Khipu Master game, 5th-grade students arrive in pre-colonial Machu Picchu, Peru and progress toward their goals by learning to use a historical base-10 positional number system as an alternative representation of the modern standard base-10 number system taught in grades 1-5 (Brezine, 2011). Khipu were an Inca system of record-keeping which made use of a number system directly analogous to our natural numbers, storing numbers as knots in strings. Khipu were even used to depict multiple relationships across sets of data using string grouping, color, and other traits (Ascher & Ascher, 1981).

This highly contextualized alternative representation of the concepts underlying the targeted math standards allowed us to structure our assessment of student learning in the game into three levels of increasingly formal learning outcomes (Hickey & Jameson, 2012). *Engagement* in learning is documented by informally interpreting the patterns of student gameplay, and then the written artifacts generated in the game. *Understanding* is assessed using "curriculum-oriented" performance assessment items aligned to game concepts in the primary and secondary targeted standards. Gains in *achievement* are measured with "standards-oriented" test items aligned to the primary targeted standards. In Khipu Master, engagement is measured in a mid-game written response to a reflective prompt, while understanding and achievement are assessed in pre-and post-tests.

Theories of situativity and apprenticeship have been applied to many educational games (Barab et al, 2007), and are central to our design choices in Khipu Master. In this study we are focused on whether we can use evidence from assessments before, during, and after gameplay to adjust design and assessment elements based on these theories in a way that improves outcomes in subsequent iterations of the game. Our design intent is for the interactive khipu to be an affordance for students to test their base-10 assumptions in a new context (Greeno, 1991). The *khipukamayoq* takes players on as apprentices, and in that role scaffolds the use of khipu, gives automated feedback depending on student actions with the khipu and, with the help of the teacher, targeted feedback on student written reflections within the game, eventually welcoming players as khipu masters themselves (Lave and Wenger, 1991).

Methods

For each implementation, before and after the implementation, students complete a mathematics assessment before and after playing the game. The assessment included ten "curriculum-oriented" items that assessed their knowledge of based ten in the context of the khipu problems. These items are "proximal" in that they are a relatively direct assessment of the skills the students were expected to learn in the game in the context they were learned.

The assessment also included ten "standards-oriented" items that assessed knowledge of base ten in conventional test contexts, drawn randomly from released test that were aligned to two targeted standards but unrelated to any particular curricular context. These items were "distal" in that they required students to transfer their new knowledge in a context that was different than the context in which they learned it. These items predict whether the knowledge students took away from the game is likely to impact achievement on high-stakes test items that are aligned to the targeted standard.

The assessments were completed online, and two different versions of each assessment were developed by making minor changes in the item values. Counterbalanced forms of each were administered and the assessment was completed online the period before beginning gameplay and the period after gameplay was completed.

We conducted a pilot implementation in a small number of classrooms, and used the result to update the design of the game, narrowing its focus to a few closely related standards, and expanded the scaffolding of conceptual elements of those standards. We tested this iteration in a larger feasibility study. After the feasibility implementation (of the first iteration), we adjusted the amount, style, and timing of feedback from the master *khipukamayoq* character.

Learning Results from the Feasibility Study So Far (first iteration)

Scores on the curriculum-oriented assessment increased from 3.06 to 4.81. This gain of 1.73 points was statistically significant [F (1, 15) = 21.0, p <.001] and very unlikely to have occurred by chance. Given a pooled standard deviation of 1.62, this gain of 1.73 points represented a gain of 1.06 SD, which just exceeded the threshold of 1 SD that is generally needed to consistently yield a statistically significant "echo" on a corresponding standards-oriented achievement test. As shown in Figure 1, the gains were very similar across the five teachers. This suggests that it is the designed and enacted game, rather than the way the game was taken up by the various teachers, which was responsible for the learning outcomes.

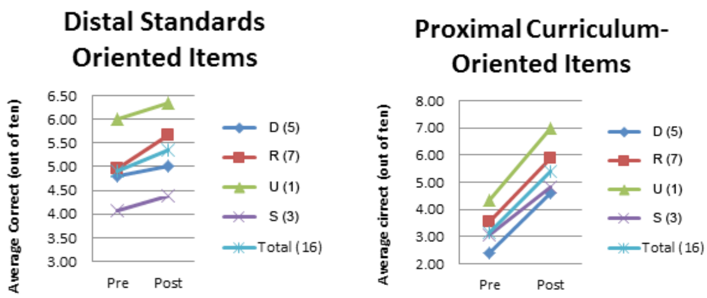

Figure 1 (a: Proximal Curriculum-Oriented Items, b: Distal Standards-Oriented Items)

Scores on the standard-oriented assessment increased from 4.06 to 4.37. This gain of .29 points did not reach statistical significance [F (1,15) = 0.8, p = .38. Given a pooled standard deviation of 1.9, this gain of .29 points represented a gain of 0.15 SD. A gain of this magnitude may or may not reach statistical significance with a larger sample size. Examination of scores by teacher shows gain in all classrooms, with somewhat larger gains in Mr. R and somewhat smaller gains in Ms. D. This may well represent chance differences.

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WhyReef: A Virtual, Educational Program Analysis

Cody Jolin, University of Wisconsin - Stout, jolinc0607@my.uwstout.edu

Abstract: During the summer of 2012, The Field Museum of Natural History (FMNH) began a collaborative project with UW-Stout in order to analyze the effectiveness of the Museum's WhyReef program. WhyReef, an online, socially interactive coral reef simulation designed for youth ages 8-16, launched in March 2009 and has since reached over 160,000 unique players. This project focused upon a robust evaluation and analysis of WhyReef's learning goals and gameplay mechanics. This was made possible by a data set of player content and statistics provided by FMNH, as well as a personal trip to FMNH to interview the WhyReef educational team. Research was divided into three topics and determined that: 1.) WhyReef is very successful in increasing coral reef attention and appreciation, 2.) The best time to launch attention-grabbing, critical events is on weekdays during the summer, and 3.) Meaningful Motion is a key gameplay mechanic for increasing WhyReef player comprehension.

Purpose of the Research

WhyReef is a virtual, interactive coral reef simulation housed within Whyville.net that launched on March 30, 2009. It is accessible for free by anyone using an internet connected computer. The WhyReef project enables students to learn about the many diverse species living within coral reefs, as well as the scientific processes that are required to understand and conserve these reef ecosystems. The educational gameplay and design elements of WhyReef, coupled with its online, social architecture, make it a prime example of successfully combining educational and entertainment aspects in a video game.

The WhyReef project is made possible by a collaboration between The Field Museum of Natural History (FMNH) in Chicago, Illinois and learning-based virtual world developer Numedeon, Inc in Pasedena, California. Numedeon created Whyville.net in 1999, and since which more than 5 million registered users have accessed Whyville (*Numedeon, Inc.*, 2012), with over 160,000 unique users visiting WhyReef. FMNH continues to regulate WhyReef and institute changes and events in pursuit of their program and learning goals. These goals include: awareness of conservation biology, ecosystem ecology, stewardship and management, and science literacy (Babcock & Aronowsky, 2010, p. 3*)*.

Before development of WhyReef began, high priority was given to a list of 30 learning goals stemming from these four, broad educational goals. Both Numedeon and FMNH strove to find an optimal balance between online gameplay and scientific authenticity. Following several successful years, FMNH wishes to examine what aspects of WhyReef made the program so successful (Babcock & Aronowsky, 2010, p. 3*)*.

This led to the formation of a collaborative effort between The Field Museum of Natural History and UW-Stout. FMNH supplied me with a data set containing selected WhyReef user statistics, writings, and digital media created by some of the over 140,000 unique users that visited WhyReef over the time period of March 30, 2009 to April 1, 2010. During this timeframe, FMNH also conducted the Kids Advisory Council (KAC). Consisting of a group of on-site and off-site youth ages 10-14, the council aimed to better understand how content knowledge is acquired by youth through a virtual world and how this is supplemented by real interaction with specimens at The Field Museum. The data set supplied by FMNH includes a wealth of first-hand data gathered during the KAC, as well as kid-produced videos showcasing what they have learned.

Research Questions

1.) How do the WhyReef program goals align with Whyville's virtual world interface?

2.) Does social activism increase during critical events, such as WhyReef's "Save The Reef" events?

3.) What game play elements and information increase WhyReef user participation and comprehension?

Methodology

Analysis began with an in-depth evaluation of the electronic WhyReef data set and was further strengthened by a personal visit to The Field Museum to interview key WhyReef team members, learn the motives behind their game design decisions, and gain a better understanding of the science that influenced the development of WhyReef.

A comprehensive analysis of the WhyReef data set is comprised of two phases: qualitative and quantitative. Qualitative analysis was used to answer Research Question 1 by coding the WhyReef user data to the set of 30 WhyReef educational goals, as listed in the WhyReef Final Report (2010). The coding process is one common to many analysis efforts that draw from qualitative data (Zheng, Spires, & Meluso, 2011, p. 194), and is described as using one's own educated judgment to determine if a criteria is met. By closely coding 85 player-written articles and examining the Kids Advisory Council results, I was able to gain an understanding of how well WhyReef accomplished its educational goals. Quantitative analysis was used to answer Research Question 2 by utilizing the statistics program SPSS to analyze a list of unique WhyReef visitors organized by day of the year. Looking at trends between critical, "Save The Reef" days and normal, non-"Save the Reef" days, as well as trends between different days of the week, produced a statistically supported solution. A mixture of both qualitative and quantitative analysis was used to answer Research Question 3. I examined the number of players that played each game, read comments left about each of them, and drew upon my own past academic and gameplay experience to form my opinion of how to best improve gameplay mechanics of WhyReef.

Results/Conclusions

Through the analysis of the WhyReef data set, I found that WhyReef is very successful in increasing coral reef attention and appreciation among its players, but could improve upon its delivery of scientific knowledge. Then, I calculated that the optimal time to conduct critical, "Save The Reef" events is on weekdays during the summer months. Finally, I determined that the best way to improve WhyReef's gameplay mechanics is through the use of Meaningful Motion. This type of motion grabs the player's attention, while supplying clues as to what the player should focus upon. This project provided valuable feedback to the WhyReef development team, as well as opened the door for the possibility of continued collaboration between FMNH and UW-Stout.

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Pedagogical Agents in Game-based Mathematics Learning in Virtual Worlds: OpenSim Project Bazaar

Heesung Kim, Taehyeong Lim, Gwynn Grandy, Sungwoong Lee, Fengfeng Ke, Florida State University
hk11f@my.fsu.edu, tl12c@my.fsu.edu, gbg11@my.fsu.edu, sl09d@my.fsu.edu, fke@fsu.edu

Abstract: This study is a part of an ongoing design-based research project to investigate whether a virtual-world game with pedagogical agents can promote the learning of fractions for 5th graders. The OpenSim-based game prototype was tested with participants majoring in mathematics and pre-service teachers in math education to investigate the usability, playability, and learning integration of the game prototype for the math learning of 5th graders. The study results indicate that the math game scenarios are engaging for students, but there are several opportunities for improving the prototype to increase learning integration and reduce extraneous cognitive load.

Introduction

The effectiveness of computer games on learning has been explored since the middle of the 20th century. Recently, virtual online games such as Second Life have shown great promise as learning tools with which learners are able to learn by applying their knowledge learned from the game to the real life. (Jarmon, Traphagan, Mayrath, & Trivedi, 2009). In this vein, Devlin (2011) also contended that computer games are ideal to support situated learning environments that allow learners to interact with something in their daily lives. In addition, computer games play a vital role in improving learners' motivation and presenting multimode representations for learners' engagement in math, and hence support mathematical learning (Ke, 2008; Moreno, 2004). In light of the effectiveness and potential of computer games and virtual online games, this study developed a virtual world environment with two math game scenarios in OpenSimulator (OpenSim). Moreover, a key element of the games is a pedagogical agent and its role in interacting with learners. The pedagogical agent, as another user in the virtual world, can provide learners with the response-specific feedback, which has a large positive impact on learning outcomes (Mason, 2001).

Method

As a part of design-based research, this study adopted expert review and user-testing methods to improve the design of a virtual game prototype (in terms of the embedded learning content, game world design, navigation, and facilitation of the virtual agent) for 5th grader math learning. The major research question is: How can we improve the usability, playability, and learning integration of the game prototype to promote math learning for 5th graders?

Setting and Participants

The study was conducted in the OpenSim-based virtual environment in which users can experience 3D virtual game scenarios that have been developed by the researchers for the purpose of the study. Six volunteers, comprised of 4 undergraduate and 2 graduate students majoring in math education or mathematics, aged 20-25, including 3 males and 3 females, participated in the study. They were given basic instructions on how to operate their avatars in the OpenSim world prior to the usability test.

Math Game Scenarios

The study included two game scenarios, with each taking 20 minutes to complete. In the first game scenario, participants learned drumbeat-making in four, eight, and sixteen beats by applying the concept of fractions. The second game scenario is ordering sushi at a Japanese restaurant. Participants were expected to apply fractions to order and calculate sushi pieces. For each scenario, a researcher controlled an avatar in OpenSim and acted as a facilitator and pedagogical agent (e.g., an experienced beat maker or a waitress) in the virtual world.

Data Collection and Analysis

Substantial data has been collected from: (1) video recording, (2) in-field observation, and (3) semi-structured interview. During the user-test sessions, the participants' game-play screen was video-recorded and the researchers compiled observation notes. After completing the virtual game scenarios, the participants completed a usability survey and answered semi-structured interview questions on their game play experiences and perceptions. A qualitative thematic analysis was conducted from the interview transcripts as well as reviewing the video recordings. The initial analysis from the result yielded an initial list of major categories (content, design, navigation and facilitation). Within these categories, consistent themes or patterns were formed and refined through iterative analysis of the data collected via interviews and in-field observations.

Findings

A set of themes on salient game features emerged from the data. First, five design needs related to the learning-play integration were discovered: (1) intuitive game-play instruction for each game scenario, (2) the selection of the appropriate level of vocabulary for both math and contextual information for the actual target audience, (3) options to adapt to diverse learners by adjusting the level of scaffolding and the pacing of learning content presentation, (4) versatility by offering both individual and group play, and (5) learning tasks during game play that are both naturalistic to the setting and engaging. To better support the five design needs, the game world design can be refined by providing: (1) more visual presentation of the learning content, and (2) more naturalistic input control to maneuver a virtual object. Finally, the game design should reduce frustration and distraction caused by navigation errors or virtual-world exploration.

Discussion

The results showed that providing timely instructions for each move (e.g., what to click and where to go) can reduce unnecessary cognitive load for learners during game play. Issues such as navigation, unsuitable vocabulary, or unclear instructions all detract from the delivery of the content. In addition, incorporating peer tutoring as a form of collaborative learning may be a way to increase students' engagement with the game and learning tasks. While all facilitators are confident with their level of expertise in 5th grade fractions, the difference between being able to use fractions in daily life and to clearly communicate fraction concepts at a 5th grade level was highlighted by this usability study.

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Gaming Bloom's: De/Reconstructing the Taxonomy for Game-Based Learning

Jayne C. Lammers, University of Rochester, jlammers@warner.rochester.edu
Victoria Van Voorhis, Second Avenue Software, Inc., tory@secondavenuelearning.com

Abstract: This poster bridges the discourses of K-12 educators and game-based learning researchers by deconstructing, then reconstructing, Bloom's Taxonomy. Here we reimagine this influential educational model, accounting for the practices evident in game-based learning. The poster will articulate and visually represent a deconstructed version of the Taxonomy. It will then present a reconstructed version, illustrating how discourses from two disparate fields come together in this new theory for game-based learning.

Rationale

As videogame designers and researchers who advocate for bringing games and their learning principles to bear on curriculum and instruction in formal school environments, we often face barriers and resistance to these ideas (Groff, 2012). These obstacles come in the form of concerns about how videogames can be used to meet the content standards guiding instruction, such as the Common Core State Standards (NGO & CCSO, 2010), and the increasing pressures that classroom teachers face in light of high-stakes assessment and teacher evaluation. As we seek to find some common ground among classroom teachers, game designers, and educational scholars, it becomes important to find connections between the theories that inform the work in each field. This poster addresses this aim by proposing a model of game-based learning derived from the influential Bloom's Taxonomy of educational objectives (Anderson et al, 2001; Bloom et al, 1956).

Theories Informing this Model

The idea presented in this poster represents an attempt to connect the theory of learning represented in the revised Bloom's Taxonomy (Anderson, et al., 2001) with what we know about games and learning (Gee, 2003, 2004; Squire, 2011).

Bloom's Taxonomy

For more than 50 years, Bloom's Taxonomy (Bloom et al, 1956) has impacted educational practice by structuring educational objectives and assessments around the following categories within the cognitive domain: knowledge, comprehension, application, analysis, synthesis, and application. In 2001, Anderson and colleagues revised the Taxonomy to reflect changes in educational research and theory. The revised Taxonomy remains a hierarchical model of cognition, moving from simple to more complex objectives as it moves from *remembering* to *creating* (See Figure 1).

Figure 1: Visualizing the Revised Bloom's Taxonomy.

Game-Based Learning

Gee's (2003) seminal work still guides the field of game-based learning. Gee found that well-designed videogames immerse players in challenging, yet plausible, learning environments and provide necessary supports for player success. Videogames provide "on-demand" and "just-in-time" information and encourage players to test out theories in a low-risk environment (Gee, 2003). Unlike the learning situations most students experience in classrooms, videogames engage learners in motivating simulations that allow multiple forms and routes to legitimate participation (Gee, 2004; Squire, 2011). In many cases, learning continues beyond the game in “affinity spaces” (Gee, 2004) where players connect around their shared interest.

Bloom’s Taxonomy De/Reconstructed for Game-Based Learning

While presenting the potential of videogames to educators (Van Voorhis & Lammers, 2013), we began deconstructing Bloom’s influential taxonomy to account for the types of learning experiences available in videogames. In particular, we recognize that videogames ask players to learn by doing, with game tasks immediately tapping into the higher cognitive levels of analyzing and evaluating. As players continue through the various levels, they apply knowledge learned in context and develop increased understanding of the game’s objectives and mechanics. Additionally, players gain content knowledge using in-game resources and information available within the surrounding affinity space. As players become more skilled and engaged, they may also contribute to the game and its affinity space by creating user-generated content. Therefore, we propose reconstructing the Taxonomy to reflect these game-based learning practices (see Figure 2).

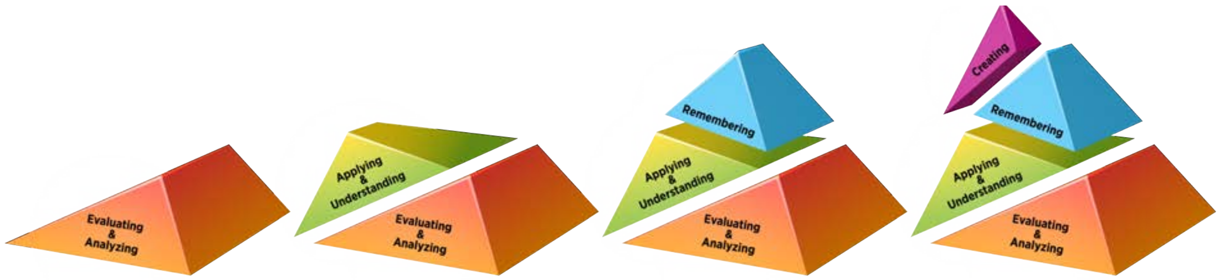

Figure 2: Bloom’s Taxonomy Reconstructed for Game-Based Learning

In this poster, we demonstrate the model’s evolution and illustrate how it bridges educator and game-based learning discourses. This presentation is our next step in developing a model designed to represent the potential of games for learning while speaking to the concerns and interests of both educators and gamers.

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Mathematics is a Game Played with Symbols

David Landy, Erin Ottmar, University of Richmond
dlandy@richmond.edu, erin.ottmar@richmond.edu

Abstract: Mathematics—at least formal mathematics—is a type of game. This game is played with symbolic shapes, and uses rules that maintain systematic relationships with a reference class of situations. Generally, formal expressions can be treated as objects that move in constrained ways through discrete states. The form of expressions provides one type of interface through which to engage mathematical meanings. We suggest here that this interface is largely outdated, relying on modes of interaction which have changed little in many decades, and that it is at least plausible that some of the anxiety experienced by many students when they encounter algebra results from the primitive nature of the interface, rather than from the game of algebra itself. We present the results of one experiment conducted in an urban middle school exploring learning in a highly structured mathematics lesson using the *Pushing Symbols* framework.

Introduction

Educational algebra games often take as an assumption that algebra is intrinsically boring. Algebraic content, in these games, derives value from being embedded in some interesting game context (e.g., *Ko's Journey; Dimension M*); indeed, it is sometimes suggested that interesting games that are intrinsically about algebra are impossible (Devlin, 2010). Along similar lines, developmental psychologists have suggested that while number and space are intrinsically interesting domains of reasoning, algebraic equations are not (Carey, 2009). In contrast, mathematicians and philosophers who describe symbolic notational systems often characterize symbol systems themselves as interesting games already--games involving the manipulation of physical objects (e.g., Haugeland, 1981). In this game, variables, operation signs, and constant symbols are pieces—physical objects—moved according to set rules. The purpose of algebraic mathematics is then to explore games that can be played within particular rule sets, and to infer properties of those games. On this account, algebras and algebraic propositions bear a kinship to physical puzzles such as Rubik's cubes: they depict objects that undergo particular transformations and exist in certain relations.

When algebra is taught, the idea of algebra as a game over physical tokens is rarely presented, and indeed physicalizing symbols is often seen as an error (e.g., Nogueira de Lima & Tall, 2007). Instead, algebraic systems are characterized by textbooks as linguistic systems, with explicit rules that must be memorized or comprehended. Because these rules appear arbitrary, they are often introduced through analogy from real-world examples, or even from the observation of patterns in particular numerical problems. The approach taken here is to apply technology—particularly touchscreen interfaces—to align the content of algebraic transformations with core cognitive and perceptual systems by making the objects of the symbolic metaphor into literal objects, which children can touch and move, and which respond in natural, object-like ways. Students can then engage in goal-directed play in a system that presents 'challenges' based on strategies and concepts involved in expression manipulation. We predicted that this system would help students engage in algebraic content more naturally, and that this interaction might increase engagement with mathematical symbol systems.

Experiment

98 sixth and seventh graders participated in a randomized-design experiment involving the pushing symbols approach. The experiment took place over 4 sessions in the students' regular classrooms. The first and last sessions were limited to a pretest and 1-month retention test; the central two days involved a lesson in the combination of like terms. There were two like terms lessons; each student received each lesson in counterbalanced order. One lesson was intended as an object-focused and game-based presentation of like terms (the *Pushing Symbols* condition); the other was intended to serve as a 'best practices' control. In each case, the lesson consisted of a short (about 5-10 minutes) lesson using the whiteboard, a physical tile activity (5 minutes), and practice using an iPad-based activity (about 30 minutes). For the Pushing Symbols group the iPad activity was a modified form of the *Algebra Touch* video game. For the control group, the activity involved using a digital pen to enter answers in a format much like a paper-and-pencil test. Each problem was followed by a worked solution. All tests consisted of 18 paper-and-pencil like terms problems.

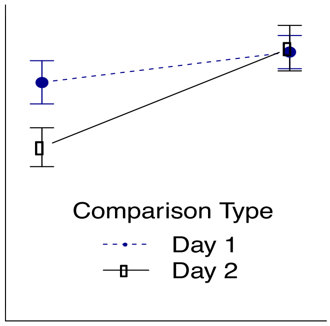

Figure 1: Mean accuracy (left), and engagement (right). Errors are standard errors.

Results

For this study, we investigated one learning outcome (structure learning) and a general measure of engagement for each of the tools. To evaluate learning differences between groups at different testing time points, we used t-tests to examine the proportion of problems solved without structure errors (see Figure 1). At pretest, there were no group differences in achievement, $t(95)=-0.78$, $p=0.44$. After the first day of instruction, students in both groups made significant gains in their understanding of simplifying expressions; however, no significant differences between those who received the Pushing Symbols intervention or the control intervention were found, $t(91)=0.17$, $p=0.86$. After the second day of instruction, significant differences emerged between conditions, $t(92)=-2.85$, $p<0.01$), suggesting an order effect and benefit of receiving the Pushing Symbols intervention first. Retention assessments 1 month later demonstrated that students in both groups retained a level of mastery for simplifying expressions.

Our second prediction was that engagement in the mathematical lesson would be higher when the algebraic interface engagement overall was quite high. Mean engagement was .75 (*SE*=1.1). An ANOVA of engagement against condition indicated higher engagement among students in the PS than in the control condition, $F(1, 86)=4.5$, $p<0.05$.

Discussion and Future Plans

A dynamic interface that allows object-like interactions with the structures depicted by mathematical symbols can be situated in a traditional lesson, and doing so can positively impact achievement and engagement. These results have implications for educators and researchers studying mathematical cognition. Examinations of algebra learning have largely been rooted, necessarily, in counterintuitive notation systems whose mastery involves explicit memorization of rules with minimal perceptual support. These results provide a preliminary demonstration that basic algebra lessons that align axiomatic algebraic content, goals, and perceptual and motor activity can yield substantial learning at least comparable to that of worked examples in the context of conceptually-oriented lessons. They call for careful investigation of learning outcomes in symbolic algebras that are intrinsically physical.

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A Design-Based Research: An Initial Model of an Embodied Cognition Based Video Game for Children with Autistic Spectrum Disorder

Sungwoong Lee, Fengfeng Ke, Florida State University
sl09d@my.fsu.edu, fke@admin.fsu.edu

Abstract: The results of this study will help identify several requirements for games that use embodied cognition technology to provide social skills interventions for children with autism. The data of observations, interviews, and multiple baseline single-subject tests will be employed and two types of analysis including phenomenological analysis and grounded-theory analysis will be employed.

Introduction

Social impairment has been identified as the main problem for Autism Spectrum Disorder (ASD) children (Bauminger, 2002; NIMH, 2012). Wing and Gould (1979) described three categories of problematic symptoms in ASD children: lack of social skills, lack of communication skills, and lack of flexibility in thinking and behavior. Research into the efficacy of social skills interventions suggests that interventions involving advanced technologies support an individualized environment which is standardized, predictable, and controllable (Golan & Baron-Cohen, 2006; Ramdoss, 2011; Wainer & Ingersoll, 2011). In fact, Weinger and Depue (2011) reported that technology-assisted interventions were associated with improved social skills within a relatively short period.

However, several unresolved issues still remain regarding the use of technologies in intervention studies. Specifically, Wong, Chan, Li-Tsang, and Lam (2009) suggested that interface design for children with disabilities requires extensive consideration because computer tasks in interventions demand specific cognitive and sensorimotor abilities. Grynszpan, Martin, and Nadel (2008) contended that if the interface is complicated, children with ASD had problems transferring knowledge gained through training. Within autism research, video games can yield appropriate environments for studies on social skills interventions (Reeve & Read, 2009).

Proposed Method

Participants

The participants in this design-based research project are five children with High Functioning Autism spectrum disorder (a.k.a Asperger's Syndrom, HFA) and five typically developing children. Children with HFA show a high degree of intelligent functioning (i.e. IQ scores above 70) and appropriate language skills (Renty & Roeyers, 2006). Since the current study is intended to provide social skills interventions, the HFA children will be appropriate participants.

Game-Based Intervention

The gameplay will encompass three sessions: an introduction session, an exercise session, and a practice session. In the introduction session, the game will provide an introduction to the game, including a brief warm-up task incorporating a think-aloud protocol interview. In the exercise session, interventions will be provided to enhance imitation, which is considered a fundamental skill for social interaction (Cook & Bird, 2012). An avatar will demonstrate five different physical gestures, and the participant will be reinforced with a token if she imitates the gestures successfully. The participant's movements will be captured using an Xbox Kinect system and will be projected into the game so that the participant can see and interact with her own movements in the game. In the practice session, the avatar will demonstrate five gestures and the participant will be required to imitate them without any reinforcement. Following the principles of DBR, the game will involve three iterative sub-studies in development as follows.

Procedure

In study 1, two participants, a child with HFA and a typically developed child, will interact with OpenSimulator-based virtual game via Xbox Kinect. Based on the study findings, a modified version of the game will be created using Blender (a 3D content creation suite) and Xbox Kinect. Another child with HFA and a typically developed child will play the game to verify its playability and funcationality in Study #2. Based on the information from sub-study #2, a final version of the game will be created using Blender and Xbox Kinect. Three children with HFA and three typically developed children will test-play the game.

Data Analysis

The current study will use a mixed-methods approach to triangulate the findings from each data source. The study will use two types of analysis: phenomenological analysis and grounded theory analysis. In the Phenomenological, this study will address the following additional question: What is the experience of children with HFA and of typically developed children in the game? At the same time, to establish a game model for social skills interventions, the current study will conduct a qualitative data analysis via the grounded-theory approach. Thus, this study will also address the question: How does this game influence the imitation abilities of children with HFA? Finally, the behavior of children with ASD will be scored with the Multidimensional Imitation Assessment (Kleeberger, 2005; Lowe-Pearce & Smith, 2005), with a scoring system from 0 (no response) to 3 (exact imitation).

Significance of study

According to the previous literature, technology-assisted interventions can be effective in enhancing social skills in children with ASD. This study explores and describes an initial game model involving social skills interventions using embodied cognition technology (i.e. the Xbox Kinect system) for children with HFA. The investigator expects that the results of this study will help to identify salient design features for games that use embodied cognition technology to provide social skills interventions for children with ASD.

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One day at the Botanical Garden: a work in progress

C. Maraschin, C. Menezes, P. Gavillon, B. Sperb, F. Teles, R. Kroeff, C. Baum, E. Raniere, G. Costa, R. Andreolla, Universidade Federal do Rio Grande do Sul
cleci.maraschin@gmail.com, credine@gmail.com, poti_gavillon@yahoo.com.br, brunosperb10@gmail.com, nandotelles@gmail.com, kroeff.re@gmail.com, baum.psico@gmail.com, edioraniere@gmail.com, guilhermescosta@gmail.com, rebeca.andreolla@gmail.com

Abstract: This work aims at presenting the initial development of a mobile game supported by the ARIS platform, to be located at the Botanical Garden, Porto Alegre / Brazil. The main assumption of this work is that the hybrid character of location-based media can increase the learning power of educational projects at the Botanical Garden's context. The game is proposed to be played by 9-12 year-old children that visit the garden. Some game developing choices and difficulties in planning the game are presented. The research group consists of researchers of the Federal University of Rio Grande do Sul and the Zoo botanic Estate Foundation.

Increasing exploration and learning in an educational context

In 2012, the research group *Oficinando em Rede* received funding for developing a location-based game. The Botanical Garden of Porto Alegre/Brazil was chosen as a research field due to its characteristics and the interest of the Botanical Garden's staff in conducting educational project in partnership with the university. Schoolchildren can have a very fun time visiting the botanical gardens. They can enjoy the shade of the trees, the wide spaces to run around and play outdoor games, the amazing and interesting facts about the flora etc. But, most of the time, the work process and philosophy of a botanical garden are not very accessible to visitors, mainly when they are very young. Maps and guided tours can help, but they are not fun and interactive enough.

The use of location-based games supported by mobile devices can be a tool for increasing exploration and meaningful learning, adding content to visit in a playful way. Location-based games present a new form of interaction that takes place within the digital as well as the concrete context. The hybrid character of location-based media can increase the learning power of educational projects.

In this project, we use ARIS (short for Augmented Reality and Interactive Storytelling) platform, "an open source tool for rapidly producing locative, interactive, narrative-centric, educational experiences" (Gagnon, 2010).

The Botanical Garden of Porto Alegre/Brazil

The Botanical Garden of Porto Alegre (http://www.fzb.rs.gov.br/jardimbotanico/) was inaugurated in 1958 with the exhibition of the earliest collections of palms, conifers, cacti, and agaváceas Liliaceae. Since 1974, it has been breeding botanical collections of trees (arboretum) organized by forest formations, botanical families and thematic groups. It has an area of 39 ha. Currently, it is considered one of the top five botanical gardens in Brazil due to the diversity of plant collections, structural qualification and training of its technical and operational staff. Its mission is to conduct integrated conservation of native flora and regional ecosystems, establishing itself as a center of reference in education, research, entertainment and culture, contributing to improving citizen's life quality.

Press start: first steps in game development

We started the game conception by making marks over a garden larger map. The marks were related to the location for the growing regions, items, hidden tips, characters and traps as they appear on the map at the start of the game.

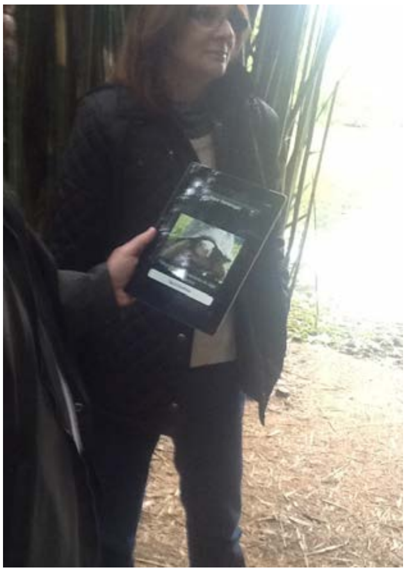
Games simulations have been made over the enlarged map, using the previous marks. After that, some new questions could be formulated. What will be the characteristic of the game: competitive, cooperative or both? In this sense, it was possible to consider different directions to the main objective of the game: (1) each player will have to plant seeds in all growing regions to win, or (2) a group of players will have to plant seeds in all regions to win. Another related factor was how to keep the scores in the game. Could players trade items with each other during the game? Could this action receive different scores (in order to reinforce the cooperative experience)?

These issues have shown us that beyond the technical problems for planning and programming a game, it is also necessary to consider the consequences of the options and their political directions.

Figure 1: The work with the map

Game Overview

In the game the players must collect seeds and plant them - in areas corresponding to each species – to save the botanical garden. To sow it is necessary that the player also collect and attach to the inventory a watering bucket, water and a shovel. These items are scattered in different locations in park.The player can plant seeds in any of the regions available and earn a point. Planting in the specific region that matches the area of the park to plant species will award two points. Receives five bonus points each player is able to plant a seed in every region correlated. The player who gets the most points throughout the game wins the match. As the player explores the garden he can choose to cooperate or not with the other participants, exchanging items or information, while he look for the items, he can find hidden tips, items and missions, as well as new characters and traps.



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GeoGame: An Online Geography Game for Learning about the Green Revolution

Brendon Mikula, Andrew Heckler, Ola Ahlqvist, Rohan Benkar, Rajiv Ramnath, Kiril Vatev
The Ohio State University
Ahlqvist.1@osu.edu, benkar.1@buckeyemail.osu.edu, ramnath@cse.ohio-state.edu, vatev.1@buckeyemail.osu.edu, heckler.6@osu.edu, mikula.20@buckeyemail.osu.edu

Abstract: Instruction in geography on the "Green Revolution" at The Ohio State University was supplemented by the *Green Revolution GeoGame* in effort to improve student understanding of the challenges and technologies of farming in developing countries. Students played through seven turns, each representing a growing season, acting out the actions of their families, including buying plots of land, planting different kinds of seeds, and choosing irrigation levels. Our results so far suggest the *Green Revolution GeoGame* gives students a better understanding of how challenging farming in developing countries can be.

The Green Revolution

Between the 1940s and late 1970s, the Green Revolution stimulated increased agricultural production in many countries. This movement, led by the "Father of the Green Revolution", Norman Borlaug, applied new technologies and research to agriculture. Some main innovations that drove the Green Revolution were the development of high-yield seeds and the improvement of irrigation systems (e.g., Evenson & Gollin, 2003).

Green Revolution GeoGame

A computer-based game was designed to supplement classroom instruction on the Green Revolution in an undergraduate General Education course on World Regional Geography. The game is integrated into the classroom as a homework assignment. After the signup process, students choose a family and use their starting funds to buy digital plots of land of varying size in India. Students play through several turns over the course of as many days, with each turn representing a growing season. Each turn, students can variably irrigate their plots; buy, sell, and plant both land race and high yield seeds; sell excess grain for profit; and buy more parcels of land. Once the student made all necessary decisions, the turn progresses and random variables such as weather and pests come into play. Family members must be fed each turn and students may purchase extra labor if necessary.

Learning Goals

The goal of the *Green Revolution GeoGame* is to give students a better understanding about the challenges of farming in developing countries. For example, students should understand the agricultural benefits gained through the introduction of high-yield seed and better irrigation, and at the same time appreciate the challenges that a farmer may face at the individual household level. During game play a built-in assessment module would ask students to respond to various prompts to gauge their understanding of the concepts presented. Most questions were given between rounds, and some were given as prompts in response to certain actions. Some example questions were:

- In your opinion, which kind of seed is better to plant, high-yield or land race? Briefly explain why.
- Farming in developing countries is hard work, but farmers can still have some measure of success. Agree or disagree?
- In your opinion, which is the most important item to spend money on, irrigation, fertilizer or high-yield seed (or some combination)? Briefly explain why.
- Did your definition or expectations of success for this game change during the course of the game? Briefly explain.

As some questions were prompted only in response to specific user actions, not all students answered all questions each round.

Results

Development of the *Green Revolution GeoGame* is still underway and only preliminary user testing results from the first development iterations are available at this point. In one semester 152 students played the game in one turn per day over the period of a week. Of these, 100 completed a voluntary survey about the game.

After playing through the seventh turn, students were asked if their definition of “success” for farming in developing countries had changed over the course of game play. Most students (55/100) stated that they did not change their definition, often maintaining their initial conservative and optimistic views for farming in the developing world. However, most students reported that they did change their definition of success. Notably, 26/100 students began the game with a business-like definition of profit and expansion, but left attempting only to provide for and maintain their own digital family. Others changed their expectations after a pest attack or a bad yield. Example responses were:

> “Yes. First I wanted to make money. Then I changed to just keeping them all alive.”
>
> “Yes. Initially I hope I would earn much money and born children. However, I can only meet the basic demand of my people now, and do not have enough saving for bad years. [sic]”
>
> “Yes because I wasn’t expecting some of the wild cards and [that threw] off my projections”
>
> “Yes right in the very beginning my expectations for success went down after I was hit with a pest attack.”

Many other students who changed their definitions did so by reporting a technical change in their specific expectations and strategy of planting and spending. Only a small fraction (2/100) of students shifted their views in the opposite direction—from survival to profit. Use of the game in subsequent terms produced similar results.

A key factor of the Green Revolution is the use of enhanced high-yield seed instead of the native land race seed. After seven rounds of game play, students were asked which type of seed, high-yield or land race, they thought was a better option for planting. Approximately 60% of students favored the high-yield seed and about 40% preferred the land race. The split opinions here serve as a good starting point for de-briefing in class after playing the game since the Green Revolution has provided both negative and positive outcomes for farmers. Despite the relative balance of seed preference, reasoning for these choices were diverse. Some example responses are shown below.

> “I think high yield is better because it’s faster.”
>
> “High yield seed is better because you can produce more in a smaller acreage.”
>
> “High yield because if you irrigate it you will get a better yield.”
>
> “Land-race. It is cheaper and more consistent.”
>
> “Land race seed because it is better equipped to deal with the weather.”
>
> “Land race because of its diversity.”

Conclusions and Future Direction

The *Green Revolution GeoGame* is a work in progress and results are still preliminary, but promising. Many students left the game with a better appreciation of the difficulties involved in the life of these farmers, and some of the strategies needed to be successful. We believe any success achieved by the game is due to the active learning environment provided by game play.

Future improvements to the *Green Revolution GeoGame* may include the addition of additional variables. Some examples include adding new regions to help students make connections between regions; adding more different social circles and types of farmers to more accurately reflect the local social landscape; or adding geographical variables such as access to water and its dependence on the lay of the land and proximity to sources. In addition to studying how added game complexity effects learning, the intent of added variables will be to make the challenges of game play reflect the actual challenges of farming in a developing country as closely as possible.

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Pre-Service Art Educators Learning from Digital Game Design

Ryan Patton, Luke Meeken, Virginia Commonwealth University
rpatton@vcu.edu, lmeeken@gmail.com

Abstract: This paper discusses the complications and complexities of teaching game design within the context of a pre-service art education course. It explores how drawing connections between game design, artmaking, and art education can help both pre-service educators, and their eventual students, meaningfully engage with this new medium. This study is the first in the field of art education to look at practical issues regarding teaching digital game design in P-12 settings with pre-service art educators. It is also designed to address social, economic, and cultural issues as related to game design and play. As such, it is important to begin to share this research with others in the field who are interested in the art educational possibilities for digital game design, as well as with those who may be skeptical of such claims.

Rationale for Video Games in the Art Classroom

Games, specifically video games, display potential to provide meaningful learning experiences for K-12 students, yet most educational research using video games relates directly to the learning that stems from game playing activities (Gee, 2005; Holden & Sykes, 2012; Shaffer, 2006; Squire, 2004; Steinkueler & Duncan, 2008). Art education research has advocated the value of making games as art projects (Peppler, 2010), or critiquing video games as visual culture (Parks, 2008), however these studies do not look at the impact of making video games as programmable media in the art classroom.

NSF-funded projects like MIT Media Lab's Scratch project utilize a design-based approach to develop computational thinking with K-12 teachers, however have difficulty implementing design-based instruction (Brennan, 2012). Art educators, conversely, are well versed in design-based activities, using the spiraling methods of imagining, creating, experimenting, sharing and reflecting to create project-based artworks in studio activities (Resnick, 2007). Consequently, the art classroom may be particularly well suited to affording game design experiences.

Rationale for Teaching Video Game Creation as 21st Century Art Skills

How can art educators best support a design-based approach to cultivate computational thinking through game making? The national K-12 art education standards currently being revised include digital technology by introducing a media arts component where students are expected to "gain fluencies in the evolving languages of interfaces, mediation, codes, and conventions" (National Coalition for Core Arts Standards, 2012).

Identifying these new media standards highlights a notable lack of art educators who are technologically qualified and skilled to teach these tools and forms of media. In addition, many digital art courses emphasize the use of commercially-available digital art making tools, which makes artists beholden to the interests of software developers (Rushkoff, 2010). This study examines the problem of changing attitudes of art educators towards programmable digital media through game making. The researchers measured changes in art educators' attitudes towards technological skills and creating programmable digital content, before and after participating in an art-based game curriculum in the context of pre-service education.

Video Game Curriculum for Pre-service Art Educators

The subjects of this study were ten undergraduate pre-service art educators enrolled in a "Technology in Art Education" course. All were traditional students taking this course during their sophomore year. Of the ten students, nine were women. Students led daily "skill shares" with their peers, introducing elementary design concepts and related programmable content, which accumulated over the semester prior to the assigned game design project. Effort was made to draw meaningful connections between traditional media art practice and game design, asking students to link the subject of their skill share ('movement,' 'gravity,' etc.) to a traditional media artists' practice – encouraging them to frame these new and abstract concepts in a familiar and concrete context.

After students learned how to make a video game by scaffolding their cumulative skill share knowledge, their final project required them to make a new video game based on the concept of agency. The concept of agency in games was linked to the avenues for (inter)action afforded the audience by the medium, i.e. the "verbs" afforded to the player by the system. Pre-service teachers critically and aesthetically scrutinized the "verbs" of a number of games, from the clichéd jumping and shooting of conventional games to more inventive “verbs” like growing old, mourning, or manipulating time. The aesthetic impact of different mechanical ways of implementing these “verbs” was also discussed. Students were then encouraged to reflect on avenues for agency they hadn’t encountered in the example games explored, and to devise a new game, built around an unconventional “verb” that might afford a new form of player agency.

Students were given required parameters for their final video game such as variables, multiple levels, and metaphoric actions. Students had the option to also create a physical computing device to play the game with. A survey measuring students’ self-identified growth in their ability and confidence to create games and programmable media was distributed at the end of the course. Students reported significant gains in their ability to create digital art, to create programmable media, and viewing video games as a medium for artistic expression from taking the course. And when new opportunities to teach video games to K-12 students became available, several pre-service students requested to interview for the teaching positions.

Conclusion

By making video games as programmable media, pre-service art education students were introduced to computational thinking as art content. Through skill shares, students were encouraged to see how game actions connect to concepts and activities of traditional art practices. At the end of the course, the pre-service teachers gained confidence in their abilities to create programmable digital art, recognizing the value of video games as art content. Through this process of making video games, art education students are more prepared to teach the skills and knowledge required of the 21st century student.

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SimQuabbin Project: Game-based Environmental Science Education in a Virtual World

J. Scott Payne, Mark Santolucito, Amherst College
spayne@amherst.edu, msantolucito@amherst.edu

Abstract: SimQuabbin is a game-based environmental simulation generated from over four decades of research data collected in the Quabbin Reservoir management area. Quests will take the form of a problem in the ecosystem that players are recruited to help solve. Players collect and analyze data, and generate hypotheses about possible solutions to the problem. Proposed changes to the ecosystem are implemented through the collective action of all members of the group. Players travel into the future to view the state of the forest resulting from alterations they have made to the environment. The goal of SimQuabbin is to teach scientific thinking and integrate online learning, field research, and classroom-based instruction.

Background

Students' interest in science tends to decline during middle and high school (George, 2000). One strategy to reverse this trend is to emphasize inquiry-based learning. More recently games have been developed and deployed in an effort to address this deficit. Emerging research suggests that gaming environments, even those intended for entertainment, provide a context for players to employ and develop scientific thinking (Steinkuehler and Duncan, 2008). Investigations of inquiry-based learning in the game River City found that students who used the game exhibited more evidence of inquiry-based learning compared to students in the paper-based control condition (Ketelhut and Dede, 2006).

The SimQuabbin game connects the tasks to be solved in the game to the real world. The Quabbin Reservoir is a tightly controlled watershed that provides the drinking water to the greater Boston area and has been a focus of research for over four decades. Students will adopt a plot that they visit in the Quabbin Reservoir area used for the game. By collecting and analyzing data and drawing conclusions about the effects of different environmental influences on the state of an ecosystem almost in their backyards, students make connections between their science instruction and their personal lives, spark an interest in science, and ultimately result in improved learning. Ideally, schools will bring students on field trips to see their plots, thereby intimating their virtual experience with a physical reality.

SimQuabbin Game Design and Instructional Activities

The SimQuabbin world currently consists of a four square kilometer section from the Northeastern part of the Quabbin Reservoir management area in Massachusetts. Scattered throughout the Quabbin management area are 32x32 meter continuous forest inventory (CFI) plots. Since the 1960s, foresters working for the Department of Conservation and Recreation have been generating data for each of these plots on the number and types of tree species, soil quality and other factors thought to have potential impact on the water quality of the Quabbin Reservoir. An agent-based model functions as the "brain" and governs all interactions among elements in the SimQuabbin ecosystem. The SimQuabbin terrain is geo-referenced, enabling students to access the GPS coordinates of the corresponding point in the actual Quabbin for any location in the game, as well as all other data associated their virtual location. The game world is initialized and populated with trees from a database of tree and undergrowth data.

In each instance of SimQuabbin, a student is introduced to a simulated environment based on actual data from 1960. Students can make changes to environmental variables such as winter and summer temperature variance, deer population, etc., then travel forward in time to view the effects of these changes. For instance, students could ban deer hunting in the year 2000 and travel to 2020 to investigate the growth in the deer population and the consequential impact on the forest. Future worlds' environmental states are calculated using an agent-based model of the historical data from the Quabbin Reservoir records.

SimQuabbin is designed to be a quest-based game. NCPs will give students new quests and the scientific instruments they need for collecting and analyzing soil, water, tree cores, etc. Quests will take the form of a problem in the ecosystem students are recruited to help solve. For instance, a park ranger (NPC) could say, "Some of the hemlock trees appear to be dying. Can you figure out what is causing this?" Students will first need to locate hemlock trees and examine them to discover that there are little white insects on the underside of the needles.

Using the data visualization and forecasting tool located in each ranger station, students can formulate and test hypotheses about the long-term effects a loss of hemlock trees would have on the health of the forest. Based on these analyses, each student will formulate a plan for stemming the spread of this invasive species. After they have implemented in the virtual environment their solution, the students can travel forward in time to see the effects of their choices on the SimQuabbin ecosystem.

Quests will be designed as instructional modules that target specific learning objectives in the Massachusetts science framework and instructional units already included in the curriculum. This will ensure maximum integration into science curriculum.

A unique characteristic of the SimQuabbin game that has potentially broad impact for learning game design is the use of scientific data to render the virtual world and the use of an agent-based model to govern the interactions between elements in the world. Similar to the Quabbin Reservoir, researchers have amassed tomes of environmental and biological data from environmentally significant areas all over the world. A longer-term goal is to use the framework being developed for SimQuabbin to generate game-based simulations of very different ecosystems (e.g. Jornada Basin in NM, Luquillo Experimental Forest in Puerto Rico). This would enable students to study ecosystems in the remote areas of the United States or even other countries. Such projects could include partner schools at those sites and support collaboration between students in different parts of the world as they study each other's ecosystems.

Future Work

Unlike pure entertainment games, SimQuabbin needs to serve a research function. In support of the research agenda for the project, SimQuabbin will collect detailed behavior-tracking data from users as they perform quests and interact in the game. The game will record completed quests, the number of attempts at each quest, and amount of assistance requested from the park ranger NPCs. These data will be analyzed to identify patterns of use associated with different outcomes in order to generate learner models and map learner trajectories. A reporting interface in the game will provide students and teachers with a summary of their progress.

We are planning on conducting the first pilots in the fall of 2014 in local elementary schools. The project team will have numerous opportunities to user test the game with students, receive feedback, and adjust the design.

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Using Virtual World Lego to Develop Fraction Understanding

Wei Qiang, Fengfeng Ke, Florida State University
Wq09@my.fsu.edu, fke@fsu.edu

Abstract: this poster presentation aims to introduce the pilot study of using Virtual Word (VW) based Lego Game to help the 5th grade students understand the mathematical concept of fraction. In this design-based study, the prototype of VW-based Lego Game was tested with pre-service teachers and math students to investigate its usability, playability, and learning integration. The data were collected via qualitative video analysis, observation, and interviewing.

Recently, using Virtual World (VW) games to help K-12 students with content learning is a popular idea for both educational researcher and game designers. The content knowledge spans from history, to science, to language (Chen et al., 2007; Von der Emde, Schneider & Kotter 2001; Urban et al., 2007). The advantages of using the VW for educational purposes are described as (a) 3D virtual world environment, where students can fully engaged in the environment; (b) affording immersive learning; (c) user can interact with the content or information via multisensory channels; and (d) fostering intuitive learning interaction within the environment (Mikropoulos & Natsis, 2011).

Many studies focused on the benefits of using Lego bricks to facilitate students' mathematic learning and problem solving skills. Hussain, Lindh, & Shukur (2006), stated that students who play Lego bricks performed better on their mathematics tests than students who do not play Lego. They also found that students do not show a significant positive attitude towards Lego. Study also indicated that Lego could promote students' learning of ratio from their construction and explanation on the concept (Norton, 2004).

In this exploratory study, we investigated the usability, playability, and learning integration of the OpenSim-based Lego game prototype for the math learning of 5th graders. Specifically, our research questions are: (1) how did users interact with the design features of the VW Lego game? And (2) how can the game be further improved to promote learning and engagement?

Methods

Participants

Six participants comprised of 3 undergraduates and 3 graduate students majoring in math education or mathematics, aged 20-25, including 3 males and 3 females, participated in the study to provide perspectives of teachers and content experts on the game prototype. They were given basic instructions on how to operate their avatars in the OpenSim world prior to the usability test.

Virtual Lego World

The game is designed by using OpenSimulator (OpenSim), the online open source server platform of virtual world. The OpenSim-based Lego World will be designed to simulate the game world of Mine Craft. The game goal is to escape from the Lego World and the evil Lego King by outwitting him. In particular, players (students) need to complete a series of Lego-based tasks, which aims to teach them the concept of fraction. Students will navigate the game world in their own avatars while one of the researchers takes the avatar of the Lego King. Each round of game-play takes around 60-75 minutes to complete.

There are two major areas for students to play: the Lego kingdom palace, and the Lego factory. The Lego kingdom palace and The Lego factory are the virtual learning places. Within the Lego kingdom palace, the king will introduce the major Lego bricks to student, the concept of Lego, and the basic concept of fraction by using Lego bricks. In the Lego factory, there are many different types of Lego bricks, and students will find the correct ones to build up one object, which are given by the king. Thus, from the pedagogy perspective, the king is the "teacher" who facilitates and scaffolds students' learning process via presenting individualized learning tasks and challenging inquiries.

Data Collection

User-testing data were collected from: (1) video recording, (2) in-field observation, and (3) semi-structured interview. The participants' game-play performance was observed and screen recorded. Participates also completed the interview on their attitudes towards the VW interface, the game design, and the story design at the end of user-testing session. A qualitative thematic analysis was conducted from the interview transcripts as well as reviewing the video recordings.

Results

All participants stated that they believe that the OpenSim-based Lego game would help fifth-grade students to understand the concept of fractions. In particular, they reported that the different color and sizes of Lego bricks had facilitated the learning process. They also considered the story line, the game world design, and the five game-based learning tasks as engaging for fifth-grade students. In particular, all six participants reported that the lack of tactical, physical sensation in interacting with the OpenSim-based Lego game did not affect their understanding of the concept of fraction at all.

However, participants all reported that it was harder to maneuver the VW Lego bricks to construct artifacts than the actual Lego brick. When building with Lego bricks in the current OpenSim-based virtual game, players were faced with three challenges: (1) intricate x, y, and z control with a three-dimensional (3D) object; (2) intricate three-dimensional position tracking, by which a player had to constantly change their standing positions and viewing angles in the virtual world to gauge the position of a 3D object; and (3) lack of full collision detection when putting two VW Lego bricks together. Five participants said it was necessary to remind them on the backdrop storyline during game play, since it was easy for them to forget why they had to complete each task. Half of the participants reported the need for more free-play time to design and construct artifacts in the VW-based Lego land.

Implication

The exploratory study findings provide valuable information for the future development of the OpenSim-based Lego game. Specifically, our next steps are: (1) seeking a more effective and intuitive way to Lego-brick maneuvering, (2) providing a more consistent game story presentation that is aligned with the learning task presentation, and (3) embedding and offering more free-play activities in the virtual Lego game.

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Gaming Goal Orientations: An Empirical Motivation Framework

John M. Quick, Robert K. Atkinson, Arizona State University
John.M.Quick@asu.edu, Robert.Atkinson@asu.edu

Abstract: Goal orientations are motivational constructs from educational research that explain how different learners seek competence. A survey study was conducted to examine the applicability of a 3x2 educational goal orientation framework to a gaming context. Using Confirmatory Factor Analysis (CFA), a 3x2 gaming goal orientation framework was established to explain player motivations across six dimensions. It is believed that the 3x2 gaming goal orientation framework will be a useful tool in continued research on player motivations.

Introduction

Goal orientations are motivational constructs that were developed over the past several decades in the field of educational research (Elliot, 2005; Payne, Youngcourt, & Beaubien, 2007). They are used to describe how different learners approach goal-oriented activities, such as classroom performance. Historically, *learning goals* (Dweck, 1986) or *mastery goals* (Ames & Archer, 1988) were described as manifesting when one aims to improve competence or achieve mastery in a task. In contrast, *performance goals* (Ames & Archer, 1988; Dweck, 1986) occur when one seeks to obtain positive (or avoid negative) judgments of competence. Extensive educational research has taken place centering around how classroom environments can be socially structured to improve student motivation (Ames, 1992; Bouffard, Boisevert, Vezeau, & LaRouche, 1995; Elliot & Dweck, 1986; Elliot & Harackiewicz, 1994; Midgley et al., 1998; Wolters, Yu, & Pintrich, 1996).

Following, Elliot and McGregor (2001) offered an expanded take on goal orientations. They conceptualized not only the preexisting learning-performance goal dichotomy, but also one of *approach* and *avoidance*. Approach is the motivation to perform well, whereas avoidance is an aversion to performing poorly. Hence, a 2x2 framework (learning vs. performance, approach vs. avoidance) was born. Substantial evidence supporting this framework was provided in a series of three studies (Elliot & McGregor, 2001). Later, a survey of more than 400 undergraduates investigated the applicability of the 2x2 goal orientation framework to gaming (Heeter, Lee, Medler, & Magerko, 2011). Participants completed both the educational questionnaire (Elliot & McGregor, 2001) and an adapted gaming version (Heeter et al., 2011). Statistically significant correlations (r = .20-.93 with all p < .001) were demonstrated between the contexts. This established preliminary evidence that goal orientations may apply to gaming.

Subsequently, Elliot, Murayama, & Pekrun (2011) further expanded the goal orientations concept by forming a 3x2 framework. Mastery goals continued to represent the personal pursuit of competence and were referred to as *self* goals. Meanwhile, performance goals were divided into interpersonal (relative to others) and absolute (relative to task requirements), thereby receiving the names of *other* and *task* goals. The approach-avoidance dichotomy remained from the earlier framework. Thus, the 3x2 goal orientation framework was established with six dimensions: Task-Approach, Task-Avoidance, Self-Approach, Self-Avoidance, Other-Approach, and Other-Avoidance. Substantial evidence supporting this framework was provided in a series of two studies and an accompanying questionnaire was published for measuring the six dimensions of the 3x2 framework (Elliot et al., 2011).

The 3x2 goal orientation framework has not been studied in a gaming context. Based on promising preliminary results (Heeter et al., 2011) this study aimed to investigate the potential for a 3x2 gaming goal orientation framework.

Method

An online survey was conducted to measure the gaming goal orientations of 301 participants from a large southwestern university in the United States. The median age of participants was 21. By gender, 70% were male and 29% were female (1% did not disclose this information). Fields of study included engineering, sciences, arts, humanities, and psychology. Respondents completed an 18-statement questionnaire that assessed their gaming goal orientations (see Table 1). The statements were adapted directly from their educational counterparts (Elliot et al., 2011) and rated on a 5-point scale from *Not true* to *Extremely true*.

Results

Elliot et al. (2011) established a 3x2 educational goal orientation structure via CFA. Accordingly, the 18 gaming goal orientation statements were structured identically to their educational counterparts. This structure exceeded acceptable fit criteria (Hair, Black, Babin, & Anderson, 2010; Hu & Bentler, 1999), with $X^2_{(138)}$ = 188.350, RMSEA = .035, SRMR = .034, and CFI = .982. Table 1 contains statement descriptions, loadings, and standard errors for the 3x2 gaming goal orientation framework.

Statement	Dimension	Load	*SE*	Std. Load
To beat the game	Task-Approach	1.000	--	.498
To win on a challenging difficulty level	Task-Approach	1.408	.195	.705
To overcome many challenges	Task-Approach	1.196	.177	.649
Avoid being defeated by the game	Task-Avoidance	1.000	--	.662
Avoid losing on a challenging difficulty level	Task-Avoidance	1.027	.114	.661
Avoid failing challenges	Task-Avoidance	.983	.112	.643
To play better than I have in the past	Self-Approach	1.000	--	.808
To play well relative to how I have in the past	Self-Approach	.995	.070	.786
To play better than I typically do	Self-Approach	.924	.063	.802
Avoid playing worse than I normally do	Self-Avoidance	1.000	--	.819
Avoid playing poorly compared to my typical performance	Self-Avoidance	.878	.058	.788
Avoid playing worse than I have in the past	Self-Avoidance	.932	.057	.841
To outperform other players	Other-Approach	1.000	--	.815
To play well compared to other players	Other-Approach	.959	.061	.823
To do better than other players	Other-Approach	1.039	.060	.859
Avoid underperforming relative to other players	Other-Avoidance	1.000	--	.793
Avoid playing poorly compared to other players	Other-Avoidance	1.018	.069	.793
Avoid doing worse than other players	Other-Avoidance	1.088	.068	.841

***Table 1*: 3x2 gaming goal orientation framework statement statistics (all p < .001).**

Discussion

The results demonstrated that the 3x2 educational goal orientation framework adapted well to a gaming context. Consequently, the six factors in the 3x2 gaming goal orientations framework describe different motivations that players may have for gaming. The foci of the six dimensions of the 3x2 gaming goal orientation framework can be described as follows. Task-Approach is the motivation to attain absolute competence. Task-Avoidance is the motivation to avoid demonstrating absolute incompetence. Self-Approach is the motivation to attain relative competence compared to one's own past performance. Self-Avoidance is the motivation to avoid demonstrating relative incompetence compared to one's own past performance. Other-Approach is the motivation to attain relative competence compared to the performance of others. Other-Avoidance is the motivation to avoid demonstrating relative incompetence compared to the performance of others.

Conclusion

The motivational concept of goal orientations, having been shown to apply to the gaming context, holds valuable insights for continued research. The 3x2 gaming goal orientations framework can be used to gain a better understanding of individual differences in gameplay motivation. Future gaming studies may be wise to consider how gaming goal orientations can provide deeper insights into the investigated phenomena.

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Verb Challenge

Alberto Ramírez Lujano, Chido Games, chidogamesmx@gmail.com

Abstract: *Verb Challenge* is a Spanish verb conjugation puzzle where the player has to identify and tap blocks with pronouns, verb stems and verb endings in order to form correct sentences to advance in the game.

Introduction

Verb Challenge is a video game for iOS that seeks to help students to improve their grasp on Spanish verb conjugation. *Verb Challenge* is in a playable beta at the time of this writing and will be released by winter 2013 at the AppStore. The game will be described according to the framework: Seven Circumstances of Game-based Learning proposed by Arena (2011).

Who is the learner?

The intended audience for this game is 18-34 year old people interested in Latin American culture and learning Spanish as a foreign language, who own or have access to an iOS device in a regular basis. The player may have basic or no knowledge of Spanish verb conjugation.

What is being learned?

Verb Challenge is intended to teach and reinforce the Spanish verb conjugation of the 100 most common verbs in Latin American Spanish. The game also helps the player to improve the four language skills: speaking, listening, writing and reading through three different gameplay modes designed to practice specific language skills (Figure 1). The game as well provides meaningful feedback for visual, auditory and kinesthetic learners through its user interface which takes advantage of the retina display, the accelerometers, the speakers, and the built-in microphone of iOS devices.

When does the learning occur?

Verb Challenge was designed with the goal of making conjugation written drills and conjugation charts obsoletes by allowing students to learn and practice Spanish verb conjugation exclusively through its gameplay. Players have to build a pyramid before sunset by tapping blocks with pronouns, (blue), verb stems (yellow) and verb endings (pink) (Figure 1). Players can make combos to get access to power-ups that will help them to succeed in their task.

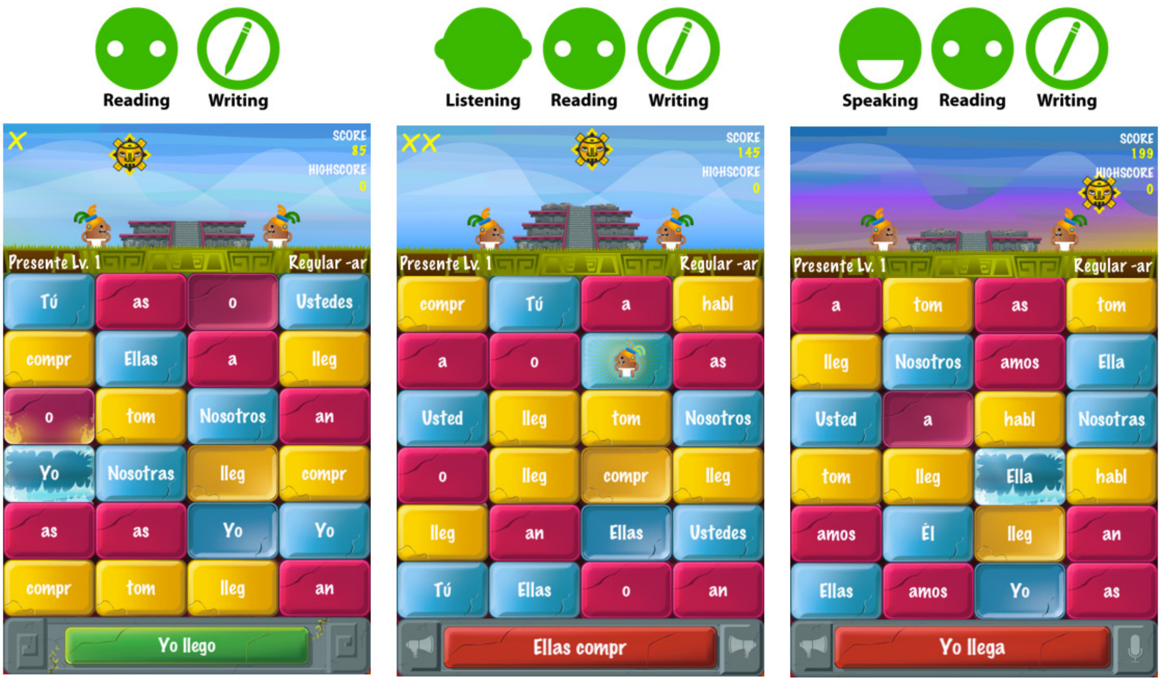

Figure 1: ***Verb Challenge*** **gameplay modes**

Why is the learner playing?

According to Adams (2010) learning occurs when at least one of the following conditions is met: (1) the learning process takes place in an enjoyable context, and (2) what is learnt provides useful mastery. Players may start playing *Verb Challenge* looking for a fast and fun way to master the Spanish verb conjugation, but they will keep playing since they will enjoy the learning process for two reasons: it takes place in and enjoyable context (the gameplay of *Verb Challenge*), and what players learn within the game will help them to advance in the game as well as in their language acquisition process. In other words the game provides useful both in-game and real life mastery to the players.

How does the learning occur?

Subject and verb ending relationship, a key aspect in Spanish verb conjugation, is intrinsically integrated within the game mechanics. The way the player discovers and learns this relationship is up to her. She can do it through trial-and-error by tapping and making different blocks combinations until the submit button turns green showing her that she made a correct sentence, or she can consult the conjugation paradigm of each verb by double tapping the verb stem block (yellow) she wants to know more about. Figure 2 shows from left to right a wrong sentence, a correct sentence and a verb paradigm. The player can as well double tap a pronoun block (blue) to get information about the pronoun he tapped, and double tap a verb ending block to get information about the tense she is currently practicing.

Figure 2: Classic Gameplay

With what does the learning occur?

Verb Challenge is a purpose-built educational game for iOS. According Johnson et al (2012), apps and tablet computing have a great potential for learning and may be broadly adopted in higher education within the next twelve months.

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Designer Research METAGame

Cary Staples, Neil Ward, Vittorio Marone, University of Tennessee
staples@utk.edu, nward4@utk.edu, vmarone@utk.edu

Abstract: Using inspiration generated in the "MetaGame as Teaching Game" (Sharp,J., Macklin,C., Daer, A., Duncan, S., Nealen, A., 2012) workshop, the authors propose a model to foster research and discussion in a design historical context. Students generate questions, then select work to represent their views and finally compete in discussions to see who can mount the most compelling argument. Students explore the aspects of concept generation, visual composition and technical use of materials through the lens of historical research.

How can we design a learning experience that will foster curiosity?

Using a gaming mindset, we hope to encourage experimentation and student initiated investigation of material presented in the historical analysis section of a beginning design course. Previous reading assignments accompanied with "compare + contrast" essays were used to access mastery of historical material. While the written documents were well crafted and factually correct, instructors noted when the students moved to generating their own ideas and solving their own problems, no bridging of the material was evident in either the conceptual discussions with the students or the visual generation of artifacts. The students were good at the process of analysis, however, no real transference or integration was occurring.

Give them the test, and let them write the answers:

Using "decade readings" that were published in Print (November/December 1989.) Students are asked to read and analyze the material specifically questioning:

	Concept	*Composition*	*Materials/technology*
Reflection / Learning outcome	*what was the idea behind the piece?* *what was the problem that the designer was attempting to solve?*	*what are the elements of composition that the designer is using to communicate his/ her message?*	*what are the materials/typefaces being used to visually convey the message?*
Q cards	"Which designer was not afraid to fail?" "Which is the best use of a cliché?"	"Which makes the most effective use of symmetry?" "Which makes the most successful use of negative space?"	"Which makes the most affective use of color?" "Which has the most innovative typography?"

Table 1: Directed questions for readings and game play

Students are introduced to the game and are asked to document the analysis of the readings in their process books. In addition to verbal analysis, students' identify visuals, from each of the readings, as well as contemporary outside sources, that support their observations. Students then generate a minimum of five cards per reading. They are instructed to select examples that might be appropriate to address multiple questions (table 1). This process encourages divergent thinking about the material, as opposed to reinforcing a "one question – one right answer" mindset. The iterative process of the development of the game is intended to model the iterative design process that students are researching. (Zimmerman, E. 2003) Making the cards is an important step in that it requires students to reflect further on their choices. Students bring their cards to class and participate in several bouts. Teams of three students participate in a series of three bouts, rotating roles. This allows each student to experience the stress of being the judge. As students do not know which questions they will receive before the game, students might have to "expand" their analysis of their cards in order to participate.

Figure 2: Preliminary and Final Bouts.

After each bout students are asked to document cards that they wish they had made or questions that they wish they had been posed from the perspective of having played the game. After the first round the question arises as to whether, when they judge, they are voting for the best card or the best argument. At this point in time, this is determined by the individual student and recorded on the game mat. In the future, this might be a way to apply a new perspective to the game.

Experience the material on a deeper level:

To get past the, “lets get this done so we can get out of here” attitude, all bouts must be documented in all participants process books to receive credit. Arguments, along with the rational for the judges decision must be recorded on game mats. Students are encouraged to expand upon thoughts they find interesting or notate if they do not agree with a specific decision made by the judge. The quality and quantity of these observations are reflected in the final grade. While comments from the students are positive, the grade is currently the best motivator.

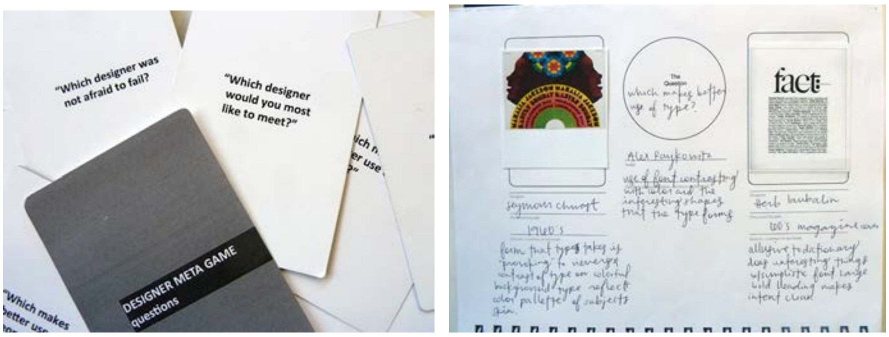

Figure 1: Qcards and Game Mat.

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Interactive Learning Assessment: Providing Context and Simulating Professional Practices

Vanessa Svihla, Elizabeth Yakes, Tim Castillo, Andrea Cantarero, & Isaac Valdez
University of New Mexico
vsvihla@unm.edu, eyakes@unm.edu, timc@unm.edu, arcantarero@salud.unm.edu, valdez.it@gmail.com

Abstract: Disciplinary practices are challenging both to teach and assess. Interactive Learning Assessment (ILA) is an online assessment that allows learners to take on expert roles—e.g., dietitian, genetic counselor—and learn content as they counsel virtual clients or patients. This poster presents results from a Fall 2012 pilot test with undergraduate students in a nutrition program (n=15). Students completed the ILA in 2-3 hours and reflected on the experience. Analysis reveals that students enjoyed learning about counseling in this manner, and that ILA allowed them to learn disciplinary content and practices—in this case, a professional nutrition counseling practice called ADIME.

Introduction

Interactive Learning Assessment (ILA) allows students to try on a professional identity while learning disciplinary content and practices, and also provides instructors with data about student learning. In previous research on ILA cases (Svihla et al., 2009), high school students were placed in expert roles such as genetic counselor or conservation geneticist and asked counsel virtual clients using resources, including the internet, to prepare responses. We contrasted ILA with traditional assessments, finding that the traditional assessments yielded an impoverished view of student capabilities. Students sometimes selected a correct answer on the traditional assessment, yet could not articulate a reason for their choice. In contrast, ILA revealed deeper information about students' ideas, including misconceptions they held. The advantage of revealing misconceptions in ILA is that they may be addressed adaptively by the assessment or by the instructor. ILA allows students to try on professional roles (e.g., dietitian), use resources (e.g. journal articles) and apply conceptual understanding by counseling virtual clients, such as a patient with diabetes. ILA helps students see connections to their future professional selves. ILA are formative, meaning they are designed to provide feedback and encourage further learning (Black & Wiliam, 1998) and focus on both content and skills, while incorporating required professional orientations, such as ethics. Research on simulation games such as ILA has shown the importance of active over passive approaches, the opportunity to revisit the simulation, and the benefit of combining such a simulation with other instruction (Dede, 2012). Likewise, ILA – like other successful approaches-- embeds academic content in situations, providing contexts for students to try, and if they fail, get useful feedback, enhancing their participation (Hickey, Barab, Ingram-Goble, & Zuiker, 2008). One of our goals is to "place disciplinary engagement in rich contexts" (Gresalfi & Barab, 2011, p. 301), allowing students to move beyond what Gresalfi and Barab term *procedural engagement*, in which students use "procedures accurately, but not necessarily with an understanding of why one is performing such procedures" (Gresalfi & Barab, 2011, p. 302). Instead, we desired for students to understand why this professional practice—ADIME (Assessment, Diagnosis, Intervention, Monitoring and Evaluation)—is important for dieticians and their clients, and to be able to make relevant professional decisions about its use; this is termed *consequential engagement* (Gresalfi & Barab, 2011).

Methods and Participants

This study reports a first iteration of a longer design-based research project aimed at refining technologies for learning and building grounded, localized theory about engaging students in professional practices as a means to support learning of both disciplinary content and practices. Our interdisciplinary team includes expertise in nutrition, learning sciences, and computer science. We designed a first case for use in an undergraduate course focusing on nutrition through the life cycle. The case provided students an opportunity to learn both the ADIME practices, and to learn about specific nutritional needs for a child with Down Syndrome. Students (n=15) completed the case out-of-class, then completed a survey. Data also include three exams, one given one week after the ILA was completed; a subset of questions from this assessment serve as a delayed post test to the ILA. Because of our small sample size, we do not report statistical test results, but rather focus on trends and particular student responses.

Results and Conclusions

Nutrition students reported that on average, they spent 2.5 hours. They overwhelmingly reported that they would use what they learned in other classes and in their careers, and that what they learned was important for their future professional work. Students also agreed that the case resembled a real life situation, though one nutrition student noted that the “Client was very compliant. Would like practice dealing with patients that are not as willing to change.” Most students felt confident that they mastered the content of the case. One nutrition student explained, “I liked that I had to think about my responses but then after I submitted my responses I got to see how the instructor interpreted the data (as she has more experience than I do in dietetics). There was a lot of information provided but it was a nice way to learn because I was actually interacting with the information instead of just hearing it.” Students were able to make use of feedback, and appreciated the formative nature of the ILA, “I liked that the case study reassured us of our answers and made us feel like there were no right or wrong answers. This helped me to really think about the questions instead of focusing on whether or not I would get full credit for being right.” We believe the feedback provided to students helped them. For instance, a student chose an incorrect answer when asked which interventions should be suggested, (“Decrease portion sizes drastically (cut all portions in half) to induce rapid weight loss (3-4 pounds per week for a month).”) but received feedback on how a professional nutritionist would respond, “Drastic weight loss is not healthy for people of any age, and if we drastically cut portion size, John will likely have inadequate vitamin and mineral intake, which can create other problems.” Students who chose incorrect answers on the ILA still performed well on the delayed post test. On the delayed post test, the average score was 98% for items related to ILA. In contrast, the average score for items targeting traditional (paper-based) cases was 89%. While not a large difference, this suggests that students may retain what they learn in ILA better than traditional approaches. However, not all students appreciated learning in this manner; most of their coursework is presented as lectures, meaning the ILA was a very different approach for them. One nutrition student commented, “I did not like having to search through research articles in order to find information that we needed to interpret lab values. Maybe summarize or synthesize the articles into smaller documents so they are easier to interpret and do not take such a long time. I also found it very difficult to keep track of all the information without taking notes.” This response suggests that as we increase our use of ILA in the nutrition program, we made need to be more explicit about why these activities—searching through articles and making notes about a case—are so important and a part of professional practice. However, other students desired to be pushed to do more, “It should encourage more independent research, not just suggest that ‘you can do more on your own if you want.’“ We note a tension between providing students with specific (often hard-to-find) resources and providing them opportunities to learn to locate resources on their own, a focus of our on-going design experiments in fostering *productive disciplinary engagement* (Engle & Conant, 2002).

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Bringing School Psychology to the sandbox: designing an educational video game

Fernando Teles, Cleci Maraschin, Universidade Federal do Rio Grande do Sul Brazil
Larissa Medeiros M. Santos, Glauber Benigno, Vinicius Guanais, Dener Silva
Universidade Federal de São João del-Rei, Brazil
Cyrille Gindreau, New Mexico State University, USA
nandotelles@yahoo.com, cleci.maraschin@gmail.com, larissa@ufsj.edu.br, glauberbenigno@gmail.com, viniciusguanais@gmail.com, densilva@ufsj.edu.br, cyrillegin@gmail.com

Abstract: This paper presents the gameplay concept for the development of a computer game to be used in undergraduate courses related to School Psychology, as an additional tool to engage professors and students at teaching and learning about school phenomena.

Introduction

School Psychology is a field aimed at promoting psychological health at school settings. In Brazil, it has been widely stated by many researchers (Antunes, 2008; Andrada, 2005; Martinez, 2009) that there are no models to follow when it comes to teach and characterize the work of a school psychologist. This is mostly because of the institutional complexity one might find at a school environment while trying to understand phenomena such as learning difficulties, troublesome student-teacher relationships, bullying and violence, to name a few.

As a branch of Social Psychology, School Psychology is supposed to avoid clinical methods to analyze and intervene in educational institutions. This, in general, implies that a school psychologist should not do psychotherapy while dealing with school problems. The focus of her work is then placed on understanding how a psychosocial problem arises and is maintained in the interrelated everyday routine of teachers, children and their families, and uses this knowledge for intervention programs.

In order to meet the educational requirements for a game-based learning experience of School Psychology, a computer game should allow the apprentice to learn how a school works and the role of a psychologist in it. Designing a game with such goals in mind is not a trivial accomplishment and demands a thorough prior study of this academic field so that its concepts, techniques and theoretical foundations can be translated into a reasonable interesting educational game.

We must stress the adjective “interesting” while referring to this educational game as we expect it to incorporate specific game design principles as opposed to instructional design approaches. By that, we mean to gather necessary resources to provide a sufficiently entertaining learning environment. In order to achieve this, we review some of both game-based education and game design literature for insights. Additionally, we draw inspiration from commercial games such as Gears of War 3 and Assassin’s Creed in an attempt to understand how their gameplay could offer relevant examples of how to engage and teach a player.

Gameplay

The game involves coping with a major problem: help prevent a school from losing its license due to its poor evaluations. The game’s main character is a school psychologist who seeks to satisfy the daily demands of the students and staff of a school in trouble. The basic mechanics of the game consists of elaborating diagnoses and proposing interventions. The player talks to other characters and gets demands that become more complex at every stage.

The game quests take place in a school and will be structured based on case studies in School Psychology. However, professors will be able to set the way a player is evaluated along a playtime. Professors will have a control panel where they can set up a gaming session, customizing problems as well as the possibilities for diagnostic interventions related to each case. The settings made by a professor will be available in the form of suggestions for other ones, creating a richer database for learning and teaching School Psychology.

We expect the player to experience our game like a hero. For this reason, he will find a problematic environment compatible with the presence of a psychologist with exceptional abilities, which is the way we present the backstory of the main character.

We expect the player to experience the role of a psychologist prior to officially being a competent licensed professional, which tends to be a common learning principle found in good video games (Gee, 2003, 2009). This could be a good strategy to foster player’s autonomy as opposed to the apprentice position. As can be noticed in the gameplay of commercial video games, the player does not need to learn to be a soldier before playing, he or she is immediately placed in the role of a soldier and develops new skills as he or she needs to deal with this condition in specific challenging contexts.

In our preliminary investigations, we have found interesting methods still exploratory to development of games for education. According to Clark (2012), it’s possible to distinguish two types of educational games: those in which the concepts of interest for learning are embedded in its mechanics and those in which the concepts are presented in an implicit way during the experience of the game. The first type would lead the player to adopt postures such as that of a scientist by requiring him or her to go around an environment, and collect data for resolving dilemmas. In the second type, the mechanics of the game is directly related to the operation of the phenomenon to be understood. The function of the player is to perform operations in the space of possibilities of a system while acting directly on a set of variables. In a study of the movement of objects according to the laws of physics, for example, a game of this type would allow the player to control values such as speed, acceleration and weight of objects, simulating movements of objects to the sake of formation of concepts. However, as Clark pointed out (2012), a conceptual formalization is more easily developed with the first type of game. We therefore expect to feed off the value of descriptive and explicit formation of concepts by including an intern to be supervised by player/psychologist in the school setting. We refer to a non playing character whose role will be to ask the player questions on the concepts and techniques common to School Psychology.

Figure 1: A psychologist (center) walking around the school.

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The Effects of Framing on Game Play Experience and Learning

Cote Theriault, Dartmouth College, cote.theriault@gmail.com

Abstract: Given the ubiquity of game play, scholars have become increasingly interested of the ways in which internal and external aspects of games may impact players**.** One external factor of importance is cognitive framing of games. The present study examined the effects of framing the board game *Blokus Duo* (Tavitian, 2005); participants were randomly assigned to one of three conditions in which the game was framed via game instructions as “spatial,” “strategic,” or was not framed. Results revealed that the spatial frame undermined women’s performance and enhanced men’s performance on a spatial reasoning test relative to the performance of participants to whom the game was not framed. Furthermore, the spatial frame negatively affected game satisfaction for participants relative to the effects of the strategic frame. General implications of these findings, particularly as they pertain to stereotype threat and the field of games for impact, are discussed.

Introduction

The ubiquity of game play (e.g., Common Sense Media, 2011) underscores the importance of studying the ways in which games impact players. Scholars have considered the influence of factors internal to games, such as content and structure (e.g.,Gee, 2003), as well as contextual factors, such as individual differences among players (e.g., Gobet, de Voogt, & Retschitzki, 2004), on game play outcomes. One contextual factor of gaming that remains to be studied is *cognitive framing* of games. Cognitive framing, according to Iyengar (1991, p. 11) involves “subtle alterations in the statement or presentation” of items.

The current study explored participants’ spatial reasoning scores and game satisfaction after playing *Blokus Duo* (Tavitian, 2005); the game was framed as spatial, as strategic, or was not framed. The study tested the following hypotheses:

1. Framing the game as spatial will negatively impact women’s spatial reasoning scores due to *stereotype threat*, which is an anxiety that arises when one performs a task “for which a negative stereotype about one’s group applies” (Steele, 1997, p. 614).

2. All participants will derive less game satisfaction when the game is framed as spatial because the label may signal that the game is educational (and therefore not fun; e.g., Hinebaugh, 2009). For women, presence of stereotype threat will also lead to decreased game play satisfaction.

3. The strategic label will boost game satisfaction and spatial performance because ‘strategy’ implies that players have *agency* in a game; evidence suggests that perceived game agency is motivating (e.g., Ryan, Rigby, & Przybylski, 2006) and may lead to cognitive growth (e.g., Vogel et al., 2006).

Methods

Participants

105 undergraduates (49 males) participated in the study and were compensated for their time.

Materials

Participants played *Blokus Duo*. The object of the game is to place 21 pieces on the game board and to cover the most area while following rules regarding piece placement. The game ends when both players run out of moves.

Procedure

Participants completed the study in pairs. Upon arrival, each pair was randomly assigned to one of three conditions: spatial game, strategic game, or unframed game. The game was framed via the rules of game play read to participants by the experimenter; otherwise, the procedure for the three conditions was identical. Participants learned the rules and then played a game against one another.

After the game, participants completed the Mental Rotation Test (Vandenberg & Kuse, 1978), which asks participants to match a given figure with two out of four choices that represent valid rotations of the original figure. Afterwards, participants completed a questionnaire composed of Likert-style questions that assessed participants’ subjective game play experience. Five items related to game play satisfaction were anchored on a 1 to 7 scale; scores were combined to create a satisfaction index (α = .81). Then, participants were verbally debriefed. Each trial lasted for 40-60 minutes.

Results

Results were analyzed with 3 x 2 analyses of variance (ANOVAs). In regard to spatial performance, a main effect of gender emerged, $F(1, 98) = 9.70$, $p = .002$, indicating that females ($M = 10.71$, $SD = 4.39$) performed worse than males ($M = 13.33$, $SD = 4.40$) across all conditions. The frame X gender interaction was also significant, $F(2, 98) = 4.60$, $p = .01$ and was analyzed with pairwise comparisons. The gender gap in performance was only significant when the game was framed as spatial, $p < .001$. Females in the spatial condition ($M = 9.11$, $SD = 4.38$) performed worse than did females in the control condition ($M = 12.35$, $SD = 4.34$; $p = .02$), while males in the spatial condition ($M = 14.94$, $SD = 4.04$) performed better than did males in the control condition ($M = 11.93$, $SD = 4.65$; $p = .05$).

In regard to game play satisfaction scores, a main effect of framing condition approached significance, $F(2, 99) = 2.44$, $p = .09$; *t*-tests revealed that participants in the spatial condition ($M = 4.59$, $SD = 1.07$) reported less game satisfaction than did participants in the strategic condition ($M = 5.16$, $SD = 0.97$; $t(68) = -2.30$, $p = .02$).

Conclusions

The findings of the current study highlight the importance of considering game framing as one crucial contextual factor when studying game play outcomes. Internal aspects of games such as content and structure (e.g., Gee, 2003) receive attention from researchers. On the other hand, although some scholars have noted the importance of the game play context (e.g., Squire, 2012), empirical research to substantiate its relevance is, thus far, scarce but badly needed in the literature. Only by studying the effects of the game play context, including game framing, can scholars fully understand the ways in which games impact players.

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Augmented Reality Family Interactions Study

Michelle Tiu, Elizabeth McCarthy, Ph.D., Linlin Li, Ph.D.,
Yvonne Kao, Ph.D., Katherine Kuhns, Priscilla Motley, WestEd
mtiu@wested.org, bmccart@wested.org, lli@wested.org

Abstract: WestEd conducted an exploratory mixed-methods study around the use of Augmented Reality (AR) technology in parent/child collaborative environments. The goal of the study was to identify when and how AR can encourage or inhibit productive learning interactions between parents and children. Most AR applications in existence have been developed for adults or older children; the developer is breaking new ground with this initiative to develop educational AR games for young children.

Research Questions

Augmented reality (AR) technology is increasingly being used in a wide variety of contexts, including in the context of learning and education. In augmented reality, a live camera feed of the real world is combined with digital images and text to create an enhanced and often interactive experience for the user. The overarching research questions guiding this work are:

1) Can AR be more effective than traditional or purely digital experiences in engaging parents?

2) Can AR be more effective than traditional or purely digital experiences in encouraging academically-oriented dialogue between parents and children during play?

Methods & Data Sources

This study focused on two AR games that were designed to help children learn about animal behaviors and habitats: *Going Batty* and *Mountain Rescue*. Both games target early elementary students (ages 6-8). *Going Batty* is a webcam-based AR game available online from PBS. It is a motion-based game, meaning that children perform physical actions that are captured by the webcam and then translated into actions within the game. *Mountain Rescue* is an AR game developed by Georgia Tech. It is a marker-based game, meaning that the camera in the mobile device used in the game recognizes printed or embedded images to trigger game actions.

Seven parent/child dyads were recruited for participation in the study. The dyads included 7 children (5 boys, 2 girls) and their parents (1 father, 6 mothers). All children participating in the study were between the ages of 6 and 8 years old (average age 7.6 years). Every parent/child dyad played both *Going Batty* and *Mountain Rescue*, one of which was in AR format and the other in non-AR format.

Family participation sessions were observed and, if the parents consented, audio recorded and video recorded. Session audio was transcribed and triangulated with observation fieldnotes. The observations focused on the user experience of the games, as well as engagement and interactions between parents and children. Researchers recorded minute-by-minute details about the stage of the game that the children were playing, the total length of play, and specific issues related to usability. They also recorded the mode of play (e.g., whether a child was playing alone or engaged with the parent), children's affect, the presence of help-seeking or helping behavior in the parent/child dyad, the presence of academically-oriented dialogue between the dyad and the presence of "scaffolding," a term coined by researchers to reference Vygotsky's (1978) notion of the role of more capable peers, parents, and others in contingently helping children's efforts to understand and learn. Children also took short pre-tests and post-tests aligned to the skills being taught in the parallel AR and non-AR games in order to collect preliminary evidence of what children may learn from playing the games.

Results

One of the most important findings of this study was the impact of AR on parents' ability to create a shared frame of reference (both child and parent able to look simultaneously at the same object) with their children, and thus on their ability to engage in effective scaffolding (the role of more capable peers, parents, and others in contingently helping children's efforts to understand and learn). We found that the AR games included in this study were not well designed for family interaction. There was no internal prompting that might involve the parents naturally in the AR gameplay. In the non-AR versions of the game, parents were able to share physical proximity with their children and easily form a shared frame of reference. In contrast, establishing a shared frame of reference was more difficult in the AR versions of the games, particularly for *Mountain Rescue*.

In the AR version of *Mountain Rescue*, the children hold the iPad and walk around in order to reach different points on a poster where they can activate various markers. Although two of the parents in our study were able to establish a shared frame of reference with their child for the duration of the game, it took concentrated effort and was often physically awkward for them to follow their child around the room. The AR version of *Going Batty* also inhibited the establishment of a shared frame of reference, largely because of the amount of physical space needed to play the game—parents needed to stand more than an arm's length away from their child in order to give them enough space to complete the movements required by the game, and the child needed to stand sufficiently far from the computer in order for enough of their upper body to be captured by the camera.

Non-AR games were found to be more conducive to shared frame of reference because of the very nature of the games—the gameplay was confined to a screen that could be observed and manipulated by both child and parent at all times during the game. Conversely, during AR gameplay, effective shared frame of reference depended highly on the involvement and engagement of the parent (e.g., were they willing to stay close to their child as their child moved around the room with the device; were they willing to stay engaged in the child's gameplay even though they themselves were no longer able to see the screen). A child's successful progression through an AR game was positively correlated with the level of active engagement on the part of the parent.

Another finding of this study addresses whether scaffolding in both the AR and non-AR conditions is related to academically-oriented dialogue between parents and children during play, and student learning. The results of the study suggest that effective scaffolding by the parent during parent/child dyad interaction is associated with increased academically-oriented dialogue in the context of scaffolding, and children's pre-test to post-test gains in both conditions. Parent/child dyads with a shared frame of reference during gameplay more effectively promoted game progress on the part of the child than those dyads without. The shared frame of reference appeared to promote effective scaffolding on the part of the parent.

Overall, the findings suggest that AR games and interactives have the potential to create rich learning environments for parent/child dyads. A shared frame of reference is crucial for the creation of these environments. As AR evolves to be used on products, such as *Google Glass*, and other versatile devices, creating opportunities for a shared frame of reference should be more feasible.

Recommendations for Future Game Development

Given these findings, we have the following recommendations for designing high-quality AR-based educational games:

- Build games that enable the parent player to be a facilitator for the child and perform actions such as initiating tasks, evaluating the child player's performance, and judging the child player's readiness for next level.
- Giving parents a separate device that will mirror what the child sees.
- Facilitate parents' scaffolding by providing rich problem-solving tasks and ensuring that parents and children can create a shared frame of reference.

Significance

The research indicates that the presence of certain factors in AR gaming experiences will increase opportunities to learn during collaborative family gameplay. AR games that are able to create shared frames of reference during gameplay and promote effective scaffolding by parents may help children learn more effectively. Though more research on the educational impact of this emerging technology is necessary, AR gaming experiences show promise of being an effective and engaging way for children to learn new content.

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Safety Nets Simplified: Simulated Decision-Making in Volatile Developing Economies

Lien Tran, University of Miami, l.tran@miami.edu

Abstract: Tanzania Social Action Fund (TASAF), the largest social protection agency in East Africa, developed a productive social safety net (PSSN) program aimed at enabling farmers to better manage their most pressing concern – rising drought risk. Faced with the challenge of communicating the complexities of this PSSN, TASAF designed and then tested a simulation game with over fifty rural farmers. This gameplay enabled these farmers to learn about TASAF's systems of conditional cash transfers and how PSSN participation can translate into added benefits for the greater community. In fall 2012 TASAF adopted this game as the sole extension tool for its national rollout targeting 13 million Tanzanians living below the poverty line. This poster outlines how the design of this inhabitable game enables this particular community to engage and understand the PSSN's complex system in order to make informed decisions that will improve their real-world livelihood.

Scientific and technological advancements enable climate scientists today to anticipate climate threats better than ever before. Humanitarian organizations now need to design, implement, and improve decision-making tools that can successfully turn early warnings into early actions (Suarez, 2009). Poor households in developing nations are particularly vulnerable to volatility and shocks caused by natural disasters and climate change, and social protection programs are increasingly seen as important tools to address disaster risk management and climate change adaptation challenges.

The Tanzania Social Action Fund (TASAF), a government organization focused on national poverty reduction and the largest social protection agency in East Africa, developed a productive social safety net (PSSN) program to help impoverished families improve their quality of life, rather than assisting in only reactionary disaster relief. In particular, the program enables farmers to better manage rising drought risk. However, explaining the magnitude of a social development program is not a straightforward task, especially to a layperson. The challenge is amplified when the information receiver has a very limited ability to read, compute, and think critically – such as a Tanzanian subsistence farmer. Yet simulation games are particularly useful in linking abstract concepts in a simplified reality by allowing players to reflect together on their shared experiences (Dorn, 1989).

TASAF management recognized the benefits of using a simulation game as a tool for communicating their new PSSN to rural farmers after playing a prototype funded by its partner the World Bank's Social Protection and Labor practice. This initial game, which simulated TASAF's systems of conditional cash transfers and how PSSN participation at the household level can translates into added benefits for the greater community, had TASAF management walk away with a better understanding of all the variable effects of their own program. As a result, TASAF requested the World Bank to commission the adaptation of this prototype to further correspond to its beneficiaries' priorities. The final game called *Uwezeshaji Kaya Kuhimili Majanga* (UKKM, meaning "enabling households to withstand") captures the core elements and relationships of TASAF's PSSN, including critical external factors like rainfall, and maps them to clear in-game choices and consequences that are familiar to Tanzanian farmers and therefore easy for them to understand.

Mendler de Suarez et al (2012) define an inhabitable game as "playable dynamic models that can meaningfully engage people in experiencing complex systems—to better understand their current or potential role in transforming them—in a way that is both serious and fun". UKKM's design as an inhabitable game makes it an efficient learning tool for improved decision-making and therefore also improved risk management. Specifically UKKM demonstrates the following characteristics, which make such games excellent experiential learning tools to explain climate risk management:

- Compressing time and space that allows for controlled experimentation without the distractions and confounding aspects present in a real-world system.
- Allowing for a comparison between the status quo and an alternative world where a productive social safety net is available.
- Enabling players to understand how their individual decisions impact the system as a whole
- Allowing all players to actively inhabit the dynamic system (no one takes a "back seat" role),

which in turn creates opportunities for peer-to-peer learning and dialogue.

- Empowering players to actively evaluate options and take action (i.e. decision-making).

In July 2012, the TASAF team tested the game in three villages in two districts with 54 farmers. After playing the game, each group of farmers shared lessons learned, including the importance of good planning and decision-making. The game also convinced them that early and regular investment in child education and health will provide a more steady income in the long-term. They also understood the importance of taking precautions to counteract the reality of climate change, like contributing labor to public works projects that mitigate climate risk for the entire local community. For example, when surveyed about how they would apply what they learned from the game in real life, one farmer on behalf of his group succinctly stated that they would: (a) invest in children, (b) keep enough savings, (c) invest in environmental protection, (d) run a productive farm with crop and livestock, (e) make good investment decisions.

In this experiential learning game, the farmers feel more connection and motivation to participate because this inhabitable game provides an immersive virtual environment where all the players are allowed to engage equally and can bring their own outside experiences and assumptions into the game (Bailenson et al, 2008). While the primary objective of the game is for players to understand the benefits of the PSSN, they also come away with an even more fundamental awareness that thoughtful decision-making is still critical to building resiliency. Many of the farmers who played the game expressed an astute understanding of the program's conditional cash transfers for education and health along with a new sense of empowerment from informed, autonomous decision-making.

Climate risk management is not an easy concept to explain to a layperson. However, simulation games inherently possess characteristics that lend themselves well to communicating climate risk and risk mitigation because they allow players to see how their decisions manifest based on unknown external conditions. While there are many considerations that go into its design, this case serves as encouragement to pursue an inhabitable game experience to communicate complex systemic information, specifically climate-related content.

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Leaving the Cave Without Losing the Transfer: ARGs and Integrated Performance in *Operation ARETE*

Roger Travis, Stephen T. Slota, Michael F. Young, University of Connecticut
roger.travis@uconn.edu, stephen.slota@gmail.com, Michael.f.young@uconn.edu

Abstract: The transfer problem troubling the game-based learning field extends backward through the annals of history to Plato's renowned Allegory of the Cave. A worked example from a course on Greek philosophical writings, in which the transfer problem itself has a key place in the learning-objectives, may therefore present a viable way forward. This paper outlines the use of an Alternate-Reality Game (ARG) layer in a learning game centering on Plato's Academy. Through that ARG-layer, the game is fully-integrated into the curriculum: the game, as a world-saving "operation," is "disguised" as the course in the same way that the shadow-puppet play of the cave is disguised as real life. Because the ARG-layer encloses a role-playing game, students, as the game/course's basic mechanic, practice transfer from the RPG to the ARG. We suggest that Plato's solution to the transfer problem may have important design implications for game-based learning in the present.

The Transfer Problem

The study of transfer (i.e., the improvement of a particular mental function and its subsequent application in another context) has troubled educational psychology since the field's inception during the early 20th century (Boring, 1929; Dewey, 1897; Thorndike & Woodworth, 1901). Detterman and Sternberg's (1993) *Transfer on Trial* perhaps framed the problem best through Gick and Holyoak's (1980) study of college student learning – in it, only one-fifth of participants were able to carry their learning experience to another, almost identical context within 24 hours of exposure to a particular problem-solving technique. Even with explicit direction indicating that the same problem solving strategy would be used on the second challenge, fewer than 50% of participants exhibited any sign of transfer. While individuals tended to learn information quite well within the presentation context (e.g., how to conquer a cube-shaped castle), they could merely recite what they had learned during the given activity without being able to put that information (i.e., "inert knowledge" (Whitehead, 1929)) to use.

After three decades of additional exploration studies like these, transfer remains extremely difficult to measure, and, as noted by Bransford and Schwartz (1999), the bridge from learning to application appears to lie within four critical situated criteria: 1) what information is being taught; 2) how directly target action parallels real-world action; 3) whether or not the activity specifically points out how and where content can be transferred; and 4) how performance and growth are facilitated by a more knowledgeable other (Brown, Collins, & Duguid, 1989; Collins, Brown, & Newman, 1989; Lave & Wenger, 1991; Young, 2004). Young et al.'s (2012) meta-review of game-based learning research highlights how this fundamental issue has widely affected the design side of contemporary studies in game-based learning. Cross-literature findings suggest that while games are good at teaching one thing really well (i.e., how to play the game), they generally fail to help students reach learning objectives unless there is a clear, isomorphic connection between the game and real-world performance. The application of standard game mechanics to a particular action or behavior seems to have little effect on achievement, something that becomes even more pronounced when comparing simulation-based training tools with more recent game-based endeavors (Honey & Hilton, 2011). As noted by Young, Slota, & Lai (2012):

> Not only is transfer quite difficult to find (e.g., Detterman & Sternberg, 1993), but the notion is premised on an assumption that the cognitive processes involved in playing a particular game are somehow identical across players and can be controlled as independent variables during empirical study...In our article, we emphasized that video game play is dynamic and situated (Brown, Collins, & Duguid, 1989). Different players play the same game with different goals, intentions, and definitions of achievement, which can lead to very different, and even opposite, academic outcomes. A player's game-player interactions change dynamically from play to play such that the same game can never be played precisely the same way twice. We can only conclude that the educational outcomes of video game play rely heavily on the nature of this interaction and not solely on the nature of the cognitive processes presumed to be involved (pp. 297).

Because many educational games so thinly parallel real world application, any information applied in the game world tends to be limited in comparison to application through other pedagogical tools like anchored instruction (e.g., CGTV, 1992), case-based learning, or constructionism (e.g., Papert, 1980). There generally tends to be little theory applied during game-based instruction implementation, and many attempts to refine these programs emphasize behavioral reinforcement (e.g., gamification) rather than complex thought processes (e.g., critical thinking, problem solving, meta-reflection). Indeed, overcoming the transfer problem to design meaningfully authentic learning games relies on both a strong understanding of the top-down approach associated with strong curriculum design (e.g., Bergmann & Sams, 2012) and an eye toward the situated nature of learning as a whole.

The Cave

Ironically, the most potent solution to our transfer dilemma may be found in a relic of the ancient world. In his Allegory of the Cave, Plato presents a culture – that is, prisoners and their relationship to the shadow-puppet play they watch as their lifelong activity – in which there is no transfer problem because learning and doing are the same:

> And now, I said, let me show in a figure how far our nature is educated or uneducated: --Behold! human beings living in an underground den, which has a mouth open towards the light and reaching all along the den; here they have been from their childhood, and have their legs and necks chained so that they cannot move, and can only see before them, being prevented by the chains from turning round their heads. Above and behind them a fire is blazing at a distance, and between the fire and the prisoners there is a raised way; and you will see, if you look, a low wall built along the way, like the screen which marionette players have in front of them, over which they show the puppets (*Republic* 7, trans. Jowett, slightly modified).

Here, Plato acknowledges the same challenge that led modern man to create formal institutions for education (i.e., schools and universities): while the cave's prisoners were able to avoid the issue of transfer, they inadvertently stumbled into a much more substantial problem – the impossibility of reflection (Figure 1). Only one prisoner, Socrates, has the luxury of achieving reflection and subsequently seeing the importance of tools like philosophy, analysis, and evaluation, or, in other words, identifying the higher-order learning objectives for which educators seek to design instruction.

Figure 1: Plato's Cave

When the enlightened (literally – he's been outside, remember) man (i.e., avatar for Socrates) returns to the cave, though, the transfer problem surfaces with a literal vengeance: as he tries to persuade his peers to stand and admire the world around them, they turn and murder him in the depths of the cave. The casual reader might assume that Plato is arguing the impossibility of teaching philosophy, though closer scrutiny reveals that he has cleverly constructed an alternative message in the style of the Wachowski's (1999) *The Matrix* character, Morpheus: no one can be told about philosophy. That is, transfer is not a simple process, and Socrates cannot provoke others into standing by lecturing them about the sun. The vast majority of those who have read *Republic*, many of them professional classicists and philosophers, have missed this detail – *Republic* itself serves as both a curriculum and game to be played by young philosophers performing as Socrates and his interlocutors (an intricacy made even more salient considering the ancients' tradition of reading aloud).

Putting the ARG-Layer to Work

Republic may be the first course to feature an ARG-layer, but, as of 2009, it was not the last. *Operation KTHMA* (Travis, 2010; Travis & Young, 2010) has helped revive Plato's pedagogical model while two similar programs of study, *Project ARKHAIA* (classics) and *Operation BIOME* (biology), have extended it to include foreign language and science instruction. However, the authors have chosen to focus on *Operation ARETE*, a game/course in Greek philosophical writings, due to its use of an ARG-layer to provide the same kind of transfer envisioned by Plato and lauded by contemporary educational psychology. In view of its classical-philosophic learning objectives, it serves as a prime example of successful instructional bridging between course, game, and real world activity.

Project ARKHAIA's ARG-layer uses the power of immersion (e.g., Gee, 2013) to evoke student performances that cross the transfer divide. When a student performs at this level, s/he demonstrates progress toward both course learning objectives and the development of underlying skills required for more progress – a dynamic that the authors have come to refer to as "continuous formative embedded assessment."

Functionally, the *Operation ARETE* instructor "recruits" his or her students at the beginning of the game/course as operatives engaged in a confidential project (i.e., *Project ARKHAIA*) run by a shadowy corporate organization known only as Mission Control. The project's prime directive, as well as that of the individual operation, is to save the world (including its peoples, cultures, and other social elements) by broadening awareness of ancient civilizations. As the operation moves forward, students (i.e., operatives) inherently accomplish this goal in themselves and one another: the transfer problem, as in Plato's cave, does not manifest since student participation in the game/course directly matches progress towards the learning objectives at a 1:1 ratio.

Within this framework, course activities are not simply the process of completing homework and attending class but instead an integral part of saving the world. Each assignment and text annotation is a collaborative effort to wrestle with Plato's ideas in the context of the students' own world. When students demonstrate growing mastery of Plato's cultural context and its influence on ethics and epistemology, they do so explicitly in order to use the ethics and epistemology embodied in Plato's works to make their lives, and the lives of those around them, better.

Importantly, the ARG-layer is used to scaffold a narrative role-playing game through which the student operatives portray young Athenians on a mission to understand Plato's philosophy and counterpose it to that of Aristotle. With the ARG layer designed to facilitate entrance into the world of the RPG, the operatives are able to fulfill the missions given to them by people like Plato (e.g., "Infiltrate the Academy, then the Lyceum"). Such performance actions, filtered through the ARG, consequently emulate the performances conducted by young philosophers thousands of years ago. Additionally, this permits students to collaborate in analyzing practices and artifacts from contemporary culture in terms of Platonic philosophy. The comedy of Stephen Colbert, for example, has served as a jumping off point for an analysis of the difference between true Socratic elenchus like that performed by Colbert and the academic philosophical discourse found in the lecture halls of philosophy departments. In this way, the interface between ARG and RPG gives students no choice but to connect their creative critical thinking in the world of the text-based simulation to their reflection on their own cultural positions. Within this framework, course activities are not simply the process of completing homework and attending class but instead an integral part of saving the world. Each assignment and text annotation is a collaborative effort to wrestle with Plato's ideas in the context of the students' own world. When students demonstrate growing mastery of Plato's cultural context and its influence on ethics and epistemology, they do so explicitly in order to use the ethics and epistemology embodied in Plato's works to make their lives, and the lives of those around them, better.

The ARG/RPG synergy described above powerfully emerges at the end of the game/course when the RPG world begins to break-down in the face of contradiction about the basic nature of philosophy (Figure 2). Can philosophy be written? Can it be taught? Plato and Aristotle disagreed on how to solve these enigmas, and their disagreement forces the operatives to craft potential solutions to the problems highlighted during the game/course (i.e., real world philosophical problems) by practicing Platonic philosophy to demonstrate that Plato was right and Aristotle wrong, or vice versa, or that both were right, or that both were wrong.

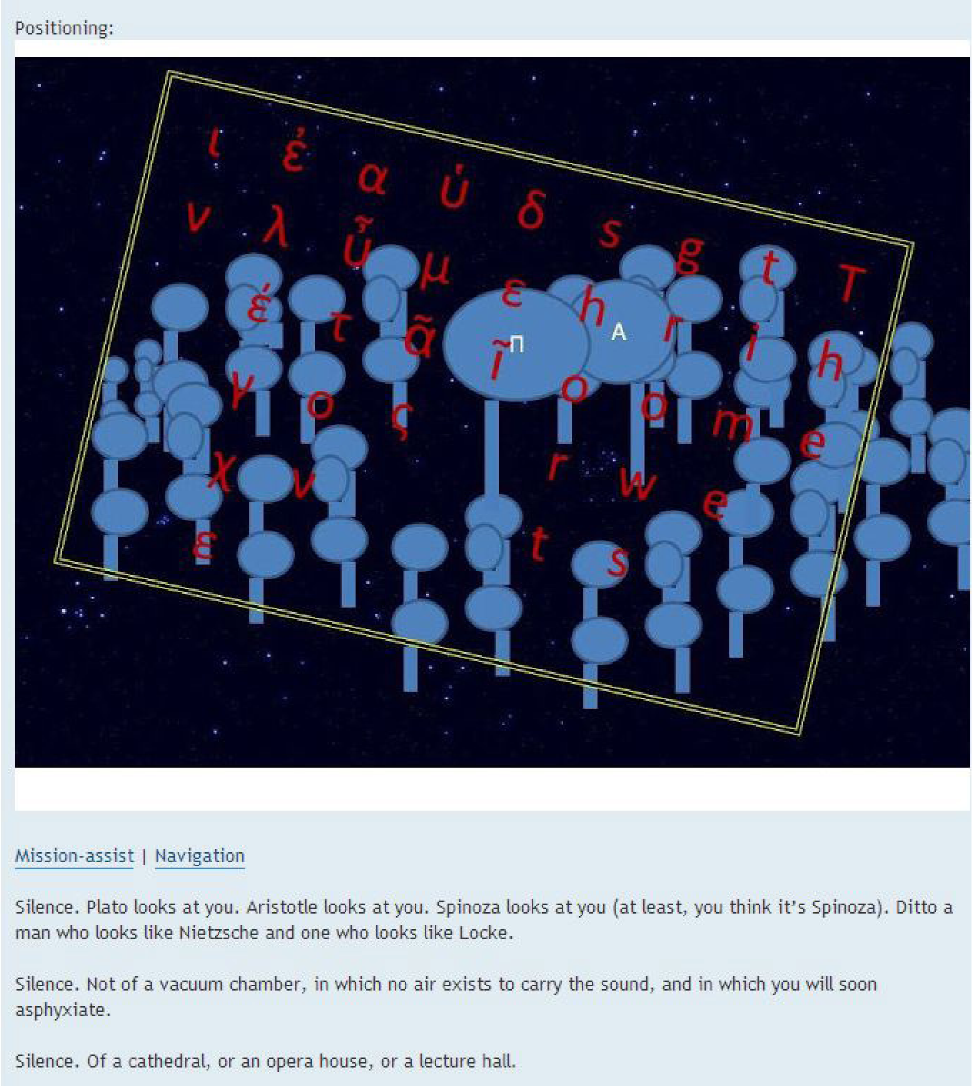

Figure 2: End of Operation ARETE

Conclusions

Providing opportunities for students to construct their own learning serves as a strong foundation for the types of discussion necessary for situated bridging (e.g., Whitehead, 1929) and gives instructors a chance to provide feedback at critical moments – something Bransford and Schwartz (1998) called the "time for telling." With that in mind, teachers, psychologists, and game designers must work together to address the schism between virtual learning and real world application in order to end the transfer problems plaguing K12 and post-secondary education. Though *Operation ARETE*'s instructional model may not be ideal or necessary for commercial game development, its dual ARG/RPG specificity to course learning objectives makes it an incredibly powerful tool for fostering the kinds of critical thinking, creativity, and reflection needed for both near and far transfer while remaining true to contemporary education theory.

As a result, Plato's cave culture may be an ideal basis for the future of game-based learning research and development. A combination of imagination, planning, and straightforward game mechanics has made it possible for the authors to bring a new generation of learners into the ancient world through something as simple as social collaboration via GoogleDocs. Using the same design backbone, any number of content areas could tackle the transfer problem head on and, we believe, help learners chained at the bottom of their own figurative caves escape into the sunlight of situated understanding and application.

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yoU Make It GO!: Mathematics at Play

The UMIGO Partnership:
WTTW Chicago, DHX Media, the Michael Cohen Group, & the Children's Museum of Manhattan

Abstract: The UMIGO partnership has the goal of increasing the numeracy acquisition, mathematics achievement outcomes, and digital competency of six to eight year-old children from low-income families. To achieve this goal, the partnership will deliver effective mathematics curriculum in the form of transmedia storytelling and activities. The partnership will provide corresponding support materials and digital resources to parents, caregivers, and teachers. The use of scientific research will allow the UMIGO partnership to establish strong evidence of the intervention's educational effectiveness and determine new measures of student performance outcomes relevant for new media learning.

UMIGO Project Overview

Developed under a five-year *Ready to Learn* grant from the U.S. Department of Education, UMIGO will encourage children to design, build and create. Michael Polis, the project's creator, explains the idea behind UMIGO this way: "When we were kids we were inventors. We thought of crazy ideas for all sorts of amazing things we wanted to make! With scraps of wood, extra screws, string, and tools from Dad's toolbox, we made things-things that were practical, that solved everyday problems...and when using our imaginations, we built fantastical things…Kids today are the same. With the proper tools and a bit of guidance, kids today can (virtually and literally) create things we could have never even imagined. At the same time, they can learn math principles by doing and making."

There are multiple entry points into the world of UMIGO, including computers, touch-screen devices such as tablet computers and smart phones, print and digital books, board games and playing cards. The world of UMIGO is not just one place, but many places where children can learn, build and share. Through a variety of activities, children will use various mathematical skills to design clothing, "mash-up" their own musical beats and create songs, produce their own virtual mazes as video game "levels," and create their own magazines and videos to share with others.

Based in empirical research, the UMIGO world will utilize developmentally scaffolded curricula in which mathematical concepts are introduced and utilized across multiple platforms with increasing complexity so that proficiency is attained. UMIGO's adherence to the Common Core Standard for Mathematics released in June 2010, will promote mathematics achievement across multiple platforms: websites, mobile phones, handheld games, television/DVDs, books, and audio formats, allowing each platform to do what is does best- present stories, change attitudes and influence behavioral outcomes through increasingly complex interactions.

Using children's natural inclinations to embrace digital media in its multiple forms, project UMIGO will utilize transmedia storytelling to "help transform children from bored, reluctant learners...to excited engaged, and creative" learners of today and the workforce of tomorrow (Gee & Levine, 2009).

Family, teachers and community are important in young children's learning. Through its outreach partnerships, project UMIGO will develop and provide training materials and digital resources for families, educators, and caregivers to help ensure that research-based mathematics instruction is infused into all aspects of children's UMIGO media activities.

Ensuring effective interventions mean utilizing rigorous measurement tools. Much of the existing literature related to children's learning and media is focused on formative stages of media product development. Formative research has been useful in assessing specific learning from children's media among small populations of children (Fisch & Truglio, 2001), identifying the most effective ways to convey educational messages in children's television shows (cf. Cohen and Rosen, 1992: Tobin and Cohen, 1997), or in the assessments of overall comprehension (cf. Trulio, Scheiner, Segui and Chen, 1999). However, there has been less research using large-scale measures to identify outcome generalizability to large populations, or summative research conducted using a scientifically based research design.

Even when outcomes are measured, there is little attention to the mechanisms (Valkenburg, 2001). Most media research has studied the impact of messages mediated through television, with far less attention to how children receive, evaluate and learn from newer media platforms. Moreover, transmedia storytelling has only recently emerged as an area of social scientific study (Jenkins, H., 2006). Project UMIGO will contribute significantly to this body of research while forging new ground by assessing media platforms both individually and collectively as a transmedia experience.

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The Island of Pi – Facilitating Math Learning through a Virtual-Reality-Based Game Intervention

Xinhao Xu, Xinrong Xue, Zhaihuan Dai, Yanjun Pan, Fengfeng Ke, Florida State University
xx11@my.fsu.edu, xx06@my.fsu.edu, zd12@my.fsu.edu, yp10d@my.fsu.edu, fke@fsu.edu

Abstract: This study is part of an ongoing design-based research project to investigate whether an OpenSim-based virtual-reality game can promote the learning of fractions and proportions for 5th graders. In this study, the game prototype was tested with pre-service teachers and math students to investigate its usability, playability, and learning integration. An adventure-themed storyline was created on a virtual world named as the *Island of Pi*, and the game-based intervention was carefully designed into three learning-by-making tasks with increasing difficulties. Data were collected via video recording, infield observation, experience survey, and interview. Findings of this study should inform designers and researchers on the design of game tasks and mechanics that reinforce content learning.

Introduction

Constructionists believe that learning is a process of knowledge construction, and effective learning happens when people actively make meaningful products in the real world (Papert & Harel, 1991). According to the situated cognition theory, learning should be integrated with activity, context, and culture: learners practice in a community, engage themselves, and acquire behaviors (Lave & Wenger, 1990).

Virtual-reality-based games have been applied to facilitate learning in different subject areas. Barkand and Kush (2009), and Vogel, Greenwood-Ericksen, Cannon-Bowers, and Bowers (2006) asserted that game-based learning environments possess pedagogical advantage by fostering motivation via play, interactivity, and challenge. When people play, they are likely to spend more time and efforts, which may lead to increased learning. The level of interactivity between the user and the game determines the depth of user involvement in the activity, and appropriate level of challenge encourages students to make attempts and motivates them to a higher level of learning (Vogel et al., 2006).

This exploratory study, as part of a design-based research project on the learning effectiveness of the virtual-reality-based math game, investigated the usability, playability, and learning integration of the game prototype for the math learning of 5th graders. Specifically, our research questions are: (1) How do users interact with the design features of the Island of Pi? and (2) How do they perceive their play and learning experience on the Island of Pi?

Intervention

We create an OpenSim-based, immersive 3D game environment, the Island of Pi (π), for 5th graders. It consists of three scenarios embedded in an adventure-themed storyline. Our goal is to help learners develop conceptual understanding and acquire calculation skills of fractions and proportions through artifact making and problem solving.

On the Island of π, Wizard Lin predicts that the island will vanish in a disaster. It is the learners' mission to seek help from the outside world and assist islanders to escape from the island by completing tasks. These tasks require increasing levels of conceptual understanding and mathematical calculations. The first scenario is paper-making, where learners calculate the right amount of paper-making ingredients to make right types of paper in order to send out a help message. The second scenario requires firework-powder making. Wizard Lin assists learners to find firework powder ingredients and calculate proportions of those ingredients so as to make and set off fireworks as SOS signals. In the third scenario – an underwater world, the ultimate task is to build an ark. Learners need to follow clues to collect wood pieces in different sizes and build the ark based on the instructions that contain fraction and proportion calculation. To make the tasks intriguing and entertaining, learners earn OpenSim dollars during game play and use them to unlock next puzzle.

Research Design

This study adopted expert review and user-testing methods to investigate the usability, playability, and learning integration of the game prototype for the math learning of 5th graders. Seven participants, comprised of 5 undergraduate and 2 graduate students majoring in math education or mathematics, aged 20-25, including 5 males and 2 females, participated in the study. They were given basic instructions on how to operate their avatars in the OpenSim world prior to the usability test. The participants' game-play performance was observed and screen recorded. After completing all three game tasks, the participants completed a usability survey and answered semi-structured interview questions on their game play experiences and perceptions. A qualitative thematic analysis was conducted with the data collected.

Findings

The results indicated that users found the scenarios engaging and the interventions instructive. The users had opportunities to develop knowledge and apply what they have learned during game play. Feedback regarding possible improvement for game design highlighted the following aspects:

1. How to maintain engagement during the intervention

   Majority of the users reported that the embedded learning content in the first scenario was overly challenging for the target learners, which exerted extra intrinsic cognitive load on the users, disrupted their engagement, made some of them rush through the task without effortful thinking. Segmenting the content into small chunks and sub-tasks may be helpful. A balanced arrangement of learning load across the three game tasks is critical. Some users felt frustrated navigating the virtual world during the treasure-hunting activity. Thus clearer clues and more scaffolding should be provided.

2. How to balance/incorporate learning and game playing parts

   Content-specific learning should be better integrated into each and every major game action. For example, a lesson learned is to integrate purposeful fraction learning into treasure hunting by asking learners to locate treasures via fraction-embedded coordinates in the map, which should also reduce the time spent on random exploration in the virtual world.

3. Whether the difficulty level of content knowledge fits learners' ability level

   The users were concerned about whether a diverse group of target learners would acquire knowledge for each game task. Thus they suggested the adoption of multiple versions of scaffolding or game-play instructions to be learner-adaptive. For example, during ark making, math disadvantaged learners could use more visual and verbal aids (e.g., 2D sketches as well as the 3D models, a composite of mini steps, number line as a visual guide) when performing fraction calculations to build each side of the ark. Another frequently mentioned suggestion is to use mathematical terminologies accurately and consistently for the target audience.

4. Content sequencing and presentation

   The data indicated that the sequencing of the learning content should be well aligned with the storyline development of the three game tasks. Specifically, the artifact-making task in a new scenario should build on and activate the knowledge learned in previous tasks. At the micro level, users suggested that the presentation of math calculation in cut-screens or media boards should use animated visuals or visual cues to highlight the flow among major and mini steps.

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Gaming the General Consequences of Learning

Steven J. Zuiker, Arizona State University, steven.zuiker@asu.edu

Abstract: This paper illustrates how videogames can productively support general consequences of learning beyond play spaces and inform alternative perspectives on the idea of learning transfer. As the empirical and conceptual adequacy of game-based and -infused models evolve, new opportunities emerge for understanding and supporting learners between and beyond play experiences. Because games foster empathy for, if not embody, meaningful social relations (Gee, 2003), they can organize and illuminate the general consequences of learning with respect to a broader nexus of factors implicated in social practice. Three complementary cases enlist the concept of consequential transitions (Beach, 1999) to towards these ends.

Introduction

Many forms of interactive media engage users in imagining possibilities for themselves and the world rather than simply showing or explaining a world to them. Such forms reflect the idea that "learning is a way of being in a social world, not a way of coming to know about it" (Hanks, 1991, p. 24). As a case in point, many videogames exemplify the idea that learning how to "be" a kind of person, or professional (e.g., soldier, doctor, thief), accompanies how to "do" the range of skillful practices associated with a particular discipline (Gee, 2005). Such games invite players to engage but, moreover, they often recruit deeper involvement, concern, and empathy. Play can also be a form of peripheral participation with the authentic value systems and identities of professionals and their attendant modes of subjectivity. As the empirical and conceptual adequacy of such game-based and game-infused models for learning and knowing evolve, new opportunities emerge for understanding and supporting learners as they move between and beyond these play experiences. This poster therefore considers the work of designing videogames and documenting impact with respect to more general yet equally productive consequences of play experiences.

Consequential Transitions across and beyond Videogames

Century-long lines of inquiry into learning transfer document ongoing discussions and intractable tensions, underscoring both the central importance and contentious foundations of transfer (e.g., Detterman & Sternberg, 1996). Special issues of *The Journal of the Learning Sciences* (vol. 21, 2012) and *Educational Psychologist* (vol. 47, 2012) featured multiple contemporary lines of research on transfer. These articles collectively concentrate on either knowledge as a discrete entity or knowing as relational practices. Regardless of how learning is theorized, however, few of the articles consider the broader context in which learning and learners interact; none consider how changes in knowing complement changes in being, namely the shaping influence that learning has on the learner. This observation punctuates earlier critiques published in the same journals (Packer & Goicoechea, 2000; Packer, 2001) and frames a fundamental research challenge that educational games can inform. In brief, this challenge is that, while learning is increasingly viewed as a broad ecological process in which social, affective, environmental, and cultural factors interact with more traditional cognitive factors, such a broad view is only vaguely reflected in empirical accounts of the general consequence of learning. The idea of *consequential transitions* (Beach, 1999) is one alternative, socio-cultural viewpoint with noteworthy implications for the interplay among games, learning, and society. A consequential transition involves a developmental change in relations between individuals and their social activities, one that is brought about through conscious reflection, personal struggle, and ultimately a change in identity or social positioning (p. 114). Because videogames can foster empathy for, if not embody, meaningful social relations (Gee, 2003), they represent a powerful medium for organizing and understanding the practices and identities of situated learning in terms of consequential transitions. Involving players not only in game play but in transitions between and beyond games can illuminate links and separations with respect to the relational practices and identities of knowing. The relative consistency of videogame contexts enables a more methodic characterization of continuity and transformation, mapping developmental trajectories of changing relations that constitute consequentiality. As a preliminary foray into better understanding the intersections of games, the learning sciences, and learning transfer with respect to educational opportunities, this paper offers contrasting cases of designing for consequential transitions with educational games.

Case 1: Consequential Transitions About and Beyond a Game

A game-based scenario challenged players to think about and beyond an immediate situation in general terms. It is designed within a *Quest Atlantis* socio-scientific inquiry curriculum (Barab, Zuiker et al., 2007). Players initially assume the role of field investigators for whom concepts like erosion become key tools for defining problems and developing solutions related to declining fish populations. Building on initial accomplishments in the game, the consequential transition unfolds when players are recruited to advise the Atlantian council and thereby into an expanded game narrative in which principles and practices related remain relevant to sustainable watersheds. The scenario enlists the player's elevated status as a frame to organize and support a developmental transition into multiple, complementary settings and documents disciplinary forms of problem finding and solving therein.

Case 2: Consequential Transitions from Games back to Classrooms

Dramatic conventions extended transitions from "as-if" videogame scenarios to "as-is" school classrooms. Using the same *Quest Atlantis* curriculum as Case 1, face-to-face activity structures enlist the game as a dramatic pretext for improvisational roleplay with props and a facilitator (Zuiker, 2013; cf. Cameron & Carroll, 2009). The consequential transition creates a two-fold challenge for participants: to negotiate a change in classroom social relations among peers and with teachers and to dialogically negotiate the unfolding significance of competing perspectives about problems and solutions related to declining fish populations and sustainable watersheds.

Case 3: Consequential Transition Cycles between Games and Classrooms

An educational game involving the dynamics of charged particles engineers a sequence of bounded episodes in which players transition from collaborative investigations during game play into small group discussions about their findings, and then ultimately into whole class debates to co-construct a shared problem space (Zuiker, Anderson et al., 2008). The interplay of games and argumentation inspires and enables authoritative and accountable participation in a disciplinary forum, arranging recurring consequential transitions across cycles of game-centered dialogic activity. Within this forum, transitions concern whole classes as a unit of analysis while individuals remain a unit of concern.

Conclusions

These three cases employ educational games to design for consequential transitions, which can support and reveal the general consequences of learning with respect to both disciplinary identities and practices as well as their changing relations across scenarios. The contrasting cases begin to establish a framework concerning productive participation beyond the local, situated contexts in which meaning emerges during game play. Insofar as productive learning must expand beyond one level of activity and includes more than one level of understanding, the idea of transitions can contribute to a more coherent and equitable system of opportunities to learn and serve a systemic agenda to understand and improve education.

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Art Exhibition

Worlds Collide: Fantasy and Reality

Curatorial Statement

The goal of the annual Art and Games exhibit is to engage the work of artists, game designers, and game artists to interrogate a general theme through the lenses of these unique but closely related fields. Games, game art, and traditional art objects are given equal weight as cultural artifacts. The theme of the 2013 exhibit for GLS 9.0 is that of colliding worlds. Not only does the exhibit collide the products of the various groups it seeks to engage, but this year the exhibit thematically collides the fantasies and realities that are depicted, utilized, and reflected in games and works of art. The boundary of fantasy and reality is permeable and shifts depending on individual perspectives. In particular we are interested in the ways in which reality is influenced, shaped, subjectively interpreted, and sometimes twisted by the intersection of fantasy. In reverse the exhibit also explores the way in which reality influences and permeates fantasy and where the boundary between the two exists. Through interactivity many of the games in the exhibit present the audience with visual as well as physical experiences where the images are works of fantasy that are engaged in reality through very real physical and emotional means. The Viewer's Choice Award Winner perhaps best exemplifies this: Don't Kill the Cow, a game by James Cox. In a 8-bit style game players are asked to make difficult and ambiguous ethical choice between killing a cow for sustenance or watching a loved one whither away. The game carries a surprising emotional weight and sense of moral ambiguity through its relatively simplistic play and visual style. The work of Stephen Hilyard, the Judge's Choice Award Winner, engages perception of fantasy and reality directly by presenting an animated but visually realistic scene of bees flying amongst a flowering tree. What at first appears as a mundane scene from nature subtly morphs into a more obvious fabrication as the bees fly in increasingly contrived patterns. Set against a soundscape appropriated from a television soap opera the piece asks a series of questions about the nature of reality influenced and viewed through modern media.

-- Arnold Martin and Mark Riechers, curators

Gone from an Age: A Fitting

Amanda Dittami and Blair Kuhlman

Despite social progress, portrayal of women in media still follows old platitudes that subject audiences to rampant negativity… Whatever their format, videogames especially tend to display women as unsubstantial characters with inhuman posture and outrageous bodies in absurd attire. While these women exist in a fictional world, their impact crosses into one that is real—and the effect is often damaging to the people on the receiving end of these unrealistic depictions of women.

The most troublesome aspect of this perverse video culture is that it highlights promiscuity and materialism in a way that adversely affects the psychological development of children and adolescents. Although such aftereffect may be unintentional, it still engineers considerable and longterm assault in the public psyche. Unsurprisingly, many women who play videogames find that their hobby reinforces or ignites body image issues. In the interim, players of various ages absorb the subliminal images of women as no more than sexual objects.

Gone From an Age: A Fitting is a satirical piece that throws the player and audience into question. What does it mean in the real world to take the role of a character who is sexualized in a digital world?

His and Hers

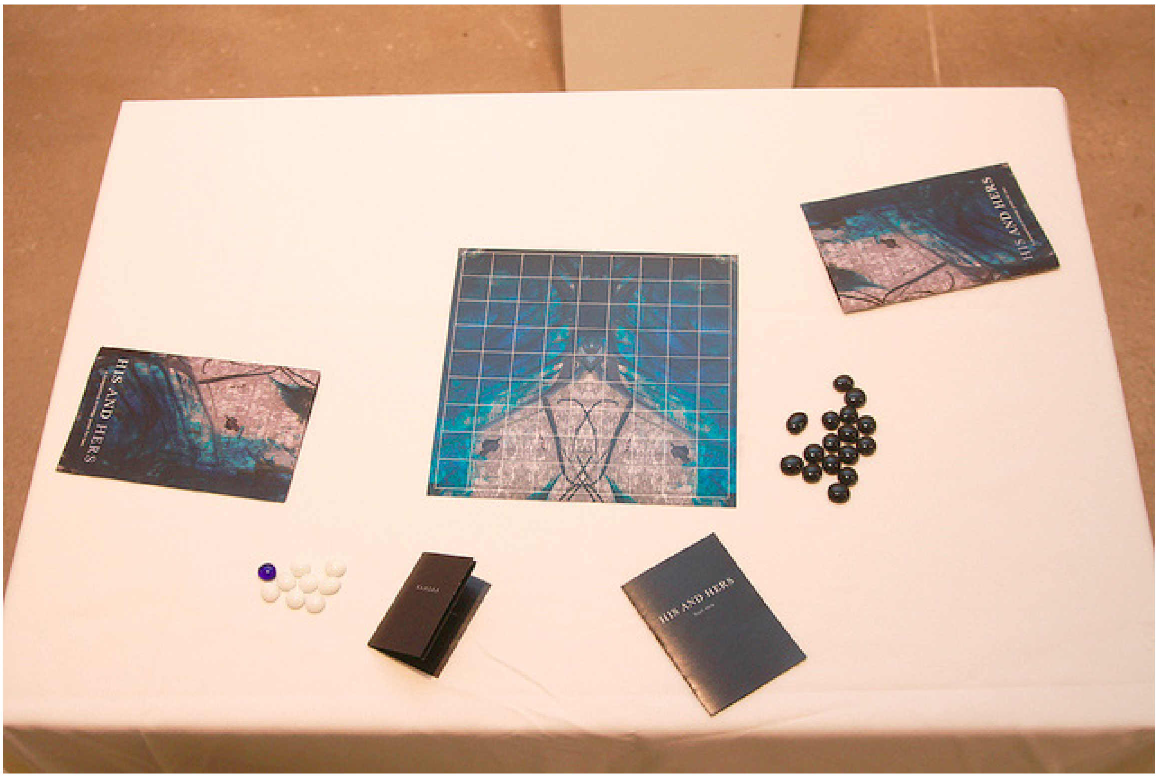
Theresa Devine

Ce n’est pas un jouet: This is not a toy.

Why do we forget to play when we grow up? Why do we hurt each other? Everywhere I look I see distrust, miscommunication, and misunderstanding. This is followed with greed, selfishness, and pain. How can play help us to understand each other? Can play transform us and our world? Play is how we learn and gain trust from each other, so can play liberate us from the cycle of hurting each other?

Through toys and games, I explore the intersection between adversity and play. Play is a serious venture and as the title says, it is not a toy. I invoke Magritte with this title because his work showed us that possibilities are only limited by our imagination. I believe that through play we release ourselves from adversity and open the door to new possibilities.

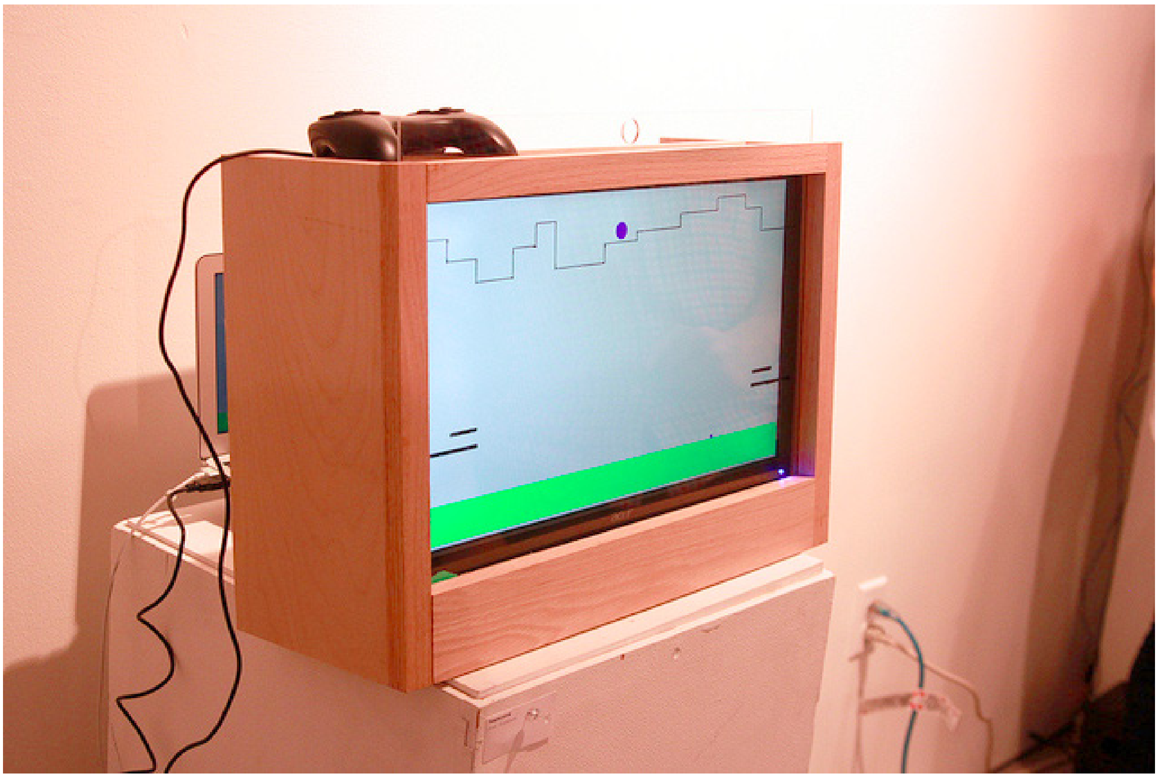
The *Ce n’est pas un jouet* body of work manifests as a series of series. This piece is from the “The World Is Flat?” tabletop game series. *His and Hers* was self-published on thegamecrafter.com on February 18, 2013.



Temperence

Josh Fishburn

Videogames have always had an element of fantasy – they allow us to take on the role of another and project ourselves into game worlds. These worlds were supplemented early on by physical screen overlays, used by both the Magnavox Odyssey and, less essentially, by the Vectrex system. In this project, I propose a single videogame to be installed with a series of screen overlays that may be swapped out at any time, with a camera or other sensor that will be able to detect which, if any, screen overlay is currently in place and adjust the game state accordingly. Conceptually, this recognizes the idea that, while we may place ourselves in a fantasy world when playing a videogame, real power comes from being able to influence or reinterpret one's construction of reality. It also acknowledges the importance of screen overlays to the construction of reality in the game space of early home videogames. Much like early game box art, which used fantastic painted images to promise an experience beyond what the simple graphics would suggest, screen overlays add a literal layer of fantasy over the limited electrical reality on the screen itself.



Lucidity

Game Changer Chicago Design Lab

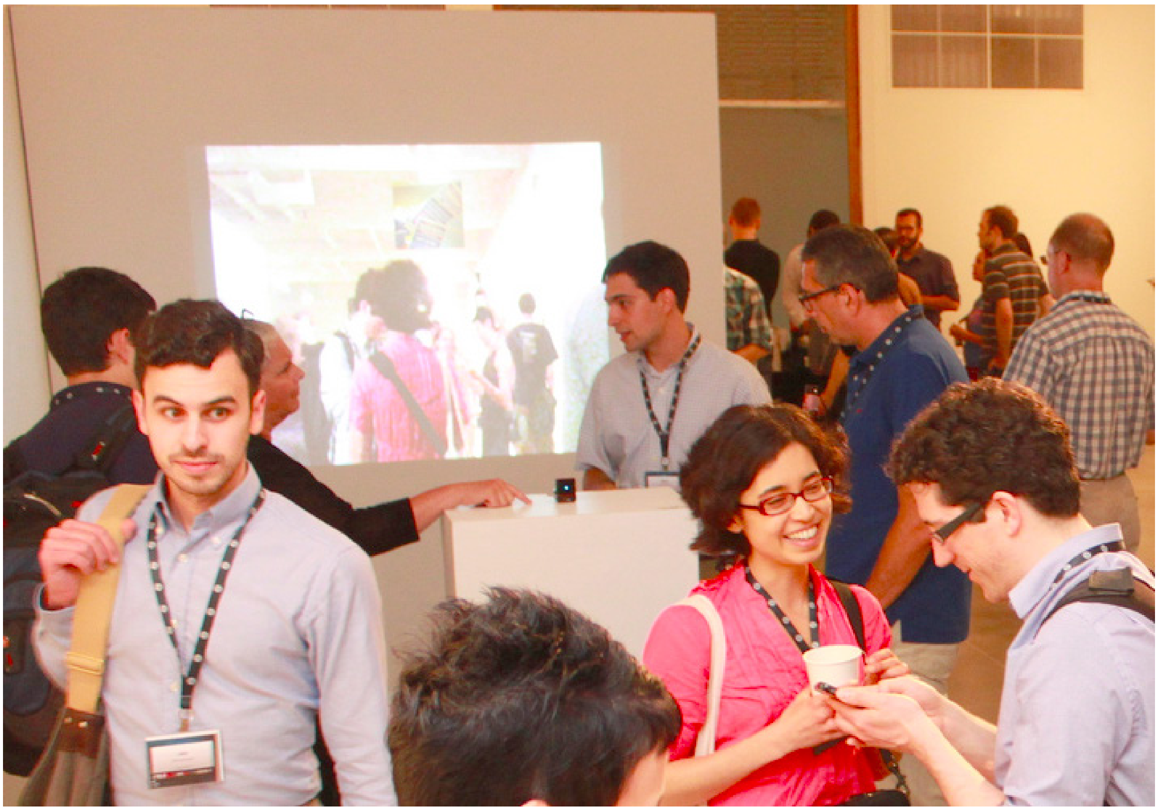
Like games, dreams refigure reality. They blur the line between the real world and the space of imagination, actuality and potential. In Lucidity, the player takes the role of a young girl named Zaria who works through a series of dreams in an attempt to piece together a difficult life event that she has tried to forget. Throughout these dreams, the event haunts her, creeping perpetually out of reach. Familiar spaces from her past and present life grow surreal, reflecting Zaria's fragmented and fractured sense of self. As the player proceeds through the dreamscape, she recombines these scattered pieces, recreating a lost narrative, developing a stronger sense of self, and leading Zaria toward a major life decision.

Instramirror

Mark Santolucito

This installation piece uses the popular picture sharing and social media platform Instagram to create a digital mirror that builds a momentary connection between people separated by space, but connected through a shared temporality. Then, as suddenly as the connection is made, a new photo of a different person replaces the participant's reflection. While this piece highlights technology's ability to create human connections, it also brings into question the persistence of those connections in a world of a constant stream of data.

Participant's can also project themselves into the digital sphere by uploading their own picture to Instagram with the special tag #GLS9ART. The program will find these photos and use them as a reflection face for a random participant. Immerse yourself in the work and experience both sides of the reality/technology mirror.



3D Printer: Self Portrait

Libby Falck

The human memory is a notoriously imperfect device. What about the “memory” of a 3D printer?

3D Printer: Self Portrait uses mixed media of 3D-printed models and black and white photography to explore the reflexive nature of personal narrative. From David Hume’s “bundle theory” to Thomas Metzinger’s “ego tunnel,” philosophers have never been able to agree where exactly to draw the line between “reality” and “fiction” in the most important narrative of our lives: the story of our selves. *3D Printer: Self Portrait* recreates the reflexive process of self-representation and memory with the story of a 3D printer: every time a “memory” is accessed and its “story” is told, it changes.

Story Shards: Assemblage of Curiosities from the Arcane Gallery of Gadgetry

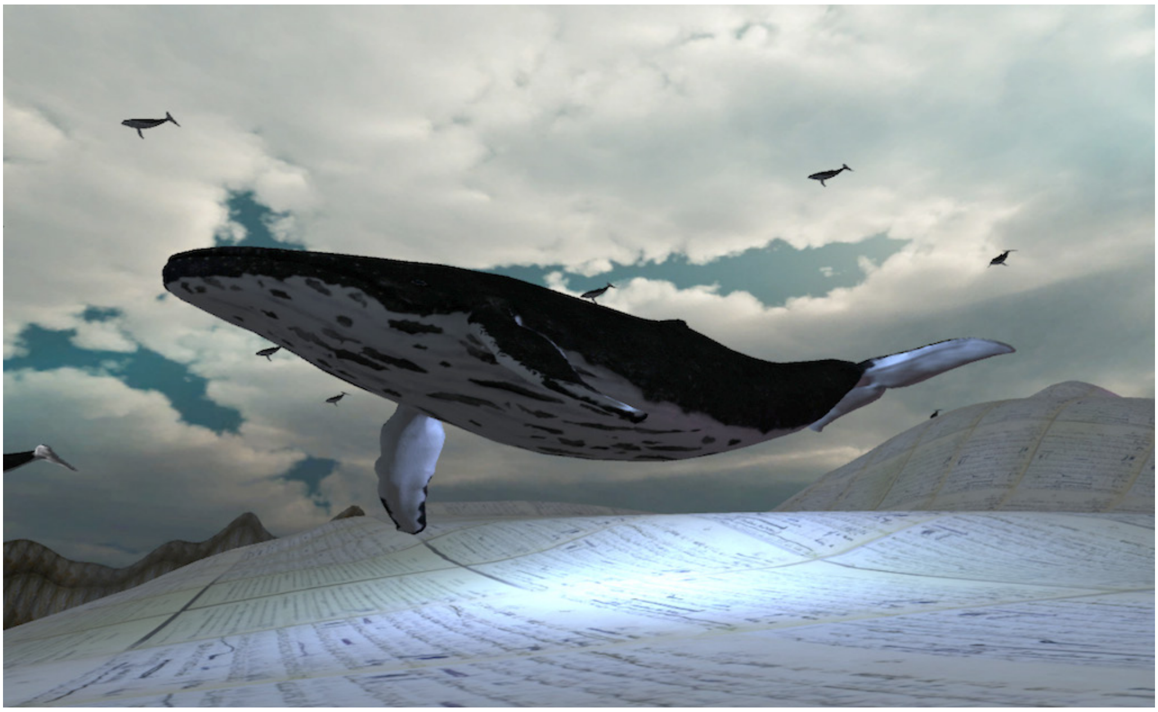
Elizabeth Bonsignore, Kari Kraus, Amanda Visconti, Derek Hansen, Ann Fraistat

In game culture, a "shard" is one of multiple servers that collectively host a MMORPG, such as *World of Warcraft.* Each shard is thus its own world within the larger universe of the game. In everyday parlance, by contrast, a "shard" is a broken piece of pottery or a fragment of glass. "Story Shards" trades on both senses of the term: it refers, on the one hand, to the artifacts that comprise the Arcane Gallery of Gadgetry—many of them works of assemblage art, made up of discrete fragments or parts—and, on the other hand, to the fictional world(s) they populate. "Shard" is also intended to convey the relationship between these two meanings: like the speaker in William Blake's "Auguries of Innocence" who can see a world in a grain of sand, the shard-as-artifact, however rough, can metonymically serve as a point of entry into the shard-as-world: a way to traverse the fabled line between reality and fiction. For the Arcane Gallery of Gadgetry, we have endeavored to create a collection of artifacts that function in just this way: as a looking glass into an alternate past.

Visions of Aleph

Karl Baumann

Videogames lie within a matrix of media, fantasy, and physical action. What would it look like to create a game world that makes explicit this complex position? *Visions of Aleph* drops the player into a world made of text and populated by flying whales, a dreamlike liminal space between fantasy and reality. The game invites poetic play and interpretation as the player explores the rich landscape. Each flying whale that they encounter triggers audio of short story snippets, so their choices and affinities within the world determine the order of the stories. With each play through, the narrative pieces are redistributed randomly and create open-ended story systems for the players to reassemble. What meaning will the player find in their various stories? Will the player discover a grounded reality within this fantastical landscape? You'll have to play to find out.



Paths and Environments

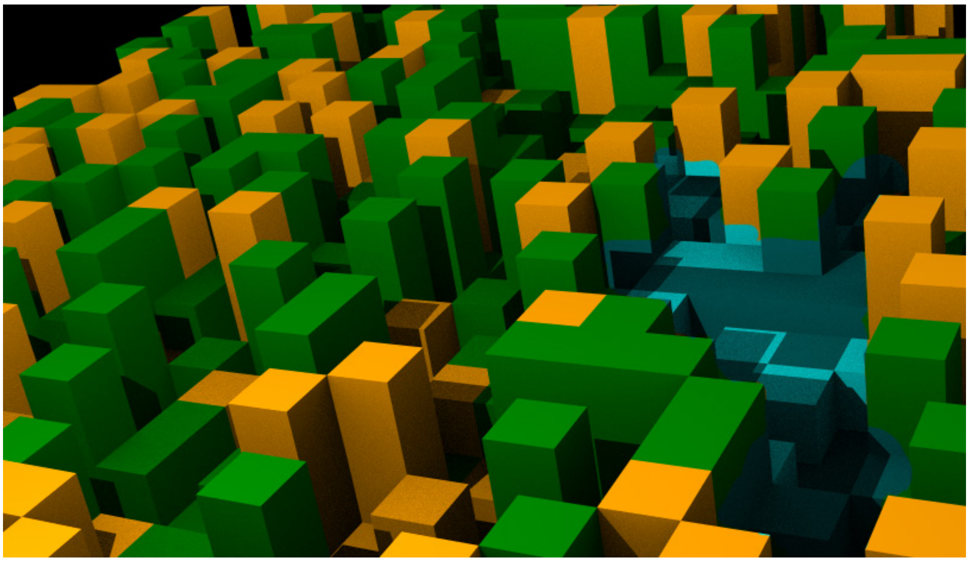
Travis Faas

Paths and Environments (P&E) is a proposed project to gather data on the usage of a public space and show the effects of the usage on an (overlaid) simulated digital environment. In specific, P&E seeks to create an augmented reality (reality with digital elements tied to it) space that parallels the installation space. This digital space will be filled with computer generated land and structures. The objects in the digital space will grow, change, and react to the usage of the installation space (usage being defined as individual paths taken through the space and places where groups congregate).The space generated will be visually similar to spaces found in procedurally generated worlds like Minecraft or the indie MMO Love.

In order to allow groups of individuals to ‘interact’ with P&E, a number of data gathering devices will need to be installed in the installation space. These devices will collect primarily visual data. The type of visual data has yet to be defined, but may range from simple 2D cameras up to 3D spatial elements collected by the Microsoft Kinect (an advanced 3D camera system developed for use with the XBOX gaming console). The data will be gathered and stored on a remote computer (server), and used to change the virtual environment as the hours and days progress. This remote computer will be the one to run the calculations that generates and changes the environment.

To view the world, a mobile phone app (Android and iOS compatible) will be developed that will display the 3D space (and allows the user to look around using a gyroscope in their phone). For those who do not own phones (and to plan for the chance that the phones do not make it into the app stores in time) a few devices or a computer will be on hand for testing during display hours. . This particular smartphone app will be developed with the Action-script 3 programing language, which allows quick development of games for multiple platforms and has a good array of resources for this project.

One major issue with augmented reality currently is tracking (or positioning) users in the simulated 3D space. There is ongoing work on trying to find a workable solution that is more accurate than GPS for use in applications like these. P&E does not propose to use any sophisticated tracking software. Instead, a minimap in the upper right hand corner of the app will let users choose where they are located within the digital ‘space’.



GLaDOS/Wheatley

Mage Lanz

Wheatley is just about to jump off his track. “Catch me, catch me!”

The original painting was for my son, after he completed Portal 2 on his own at only 7 years old. Wheatley was his favorite character from the game, and out of all the things in the world, this is what he wanted me to paint for him. I was really impressed at what an impression a simple video game robot could make.

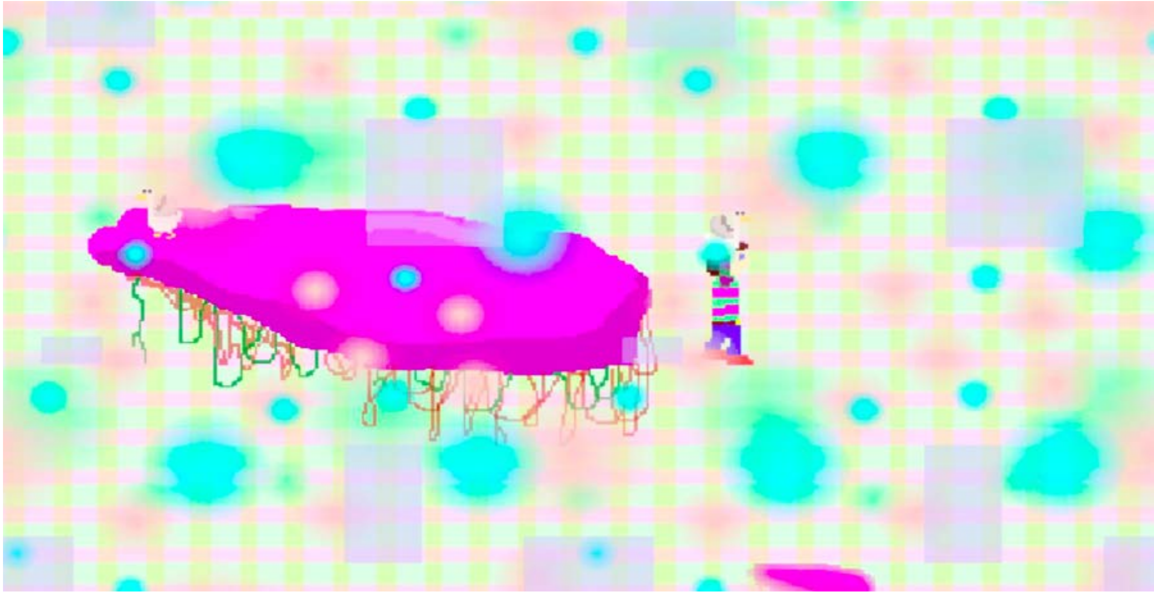
GLaDOS has just been reanimated. “Oh, it’s you. It’s been a long time.”

The original painting was for my son, to match his “Wheatley” painting. As I began it, I rewatched the scene where GLaDOS is awakened by Wheatley many times. I tried to capture the sense of dread and helplessness the player feels when Chell’s nemesis from the previous game is coming back to life.

The Duck Game / Don't Kill the Cow

James Earl Cox III

The Duck Game is a short interactive experience about a man and a duck. And his addiction to ducks. As the game progresses and his metaphysical journey continues, is quitting as easy as it may seem?



Don’t Kill the Cow

James Earl Cox III

Don’t Kill the Cow is a sidescrolling critical game that questions the importance of goals and authority in games. There is only one way to win: ‘don’t kill the cow’, but is winning the game worth it? How much do the simple phrases like ‘you win’ and ‘you lose’ mean to the player?

Zombie Yoga – Recovering the Inner Child

Doris C. Rusch

“Zombie Yoga” is a single-player Kinect game created at DePaul University by team “Lab707”. It hovers at the intersection of outer and inner life, aiming to bridge the gap not only between the real-life space of the player and the fictional space on screen, but also between motion (physical input) and emotion (inner states). It draws on the body – mind connection and understands physical action as an expression of inner processes as well as a vehicle to positively impact them. It is a metaphorical game, exploring the idea of the “inner light” and how visualizing it and even controlling it (in this case through Yoga poses) can create a sense of agency and empowerment in players. Inspired by a range of spiritual and psychological practices ranging from inner child meditations to symbolic modeling and shamanic journeying, “Zombie Yoga” intends to provide access to and productive contemplation of otherwise intangible themes such as “loss”, “individuation”, “recovery of playfulness” and “liberation of the inner child”.

One Life

Stephen Hilyard

All of my work relates in some way to a quality of experience that has been described as “The Sublime”, often described as an ecstatic experience that places the viewer within some kind of larger context, whether it may be the wilderness, the cosmos or the sacred. I believe that there is something universal about the attraction of the Sublime, a lot of my recent work is inspired by the fact that the human mind has always longed for this quality of experience, has always struggled to encapsulate it in its creations, and yet so often this fails, so often we fail to experience the Sublime, and we fail in our attempts to express it to ourselves or to others. In spite of this we continue to struggle for an experience of the Sublime and for some form of expression capable of capturing it, some way to keep it and hold it close forever. A large part of what we call “kitsch” is a result of such failed attempts to encapsulate the profound. For me there’s something tragic in this yearning for such an un-presentable concept, maybe even pathetic, but there’s also something heroic in the persistence of the Sublime impulse. Whereas my work once attempted to capture the essence of the Sublime, now it uses the visual rhetoric of the Sublime to explore those aspects of self that conspire to frustrate our experience of it.

Making an Apple Pie from Scratch

Mage Lanz

“If you wish to make an apple pie from scratch, you must first invent the universe.” -Carl Sagan

The original was commissioned in 2012 in honor of a new business venture, so the idea of creation was essential to the message of the painting.

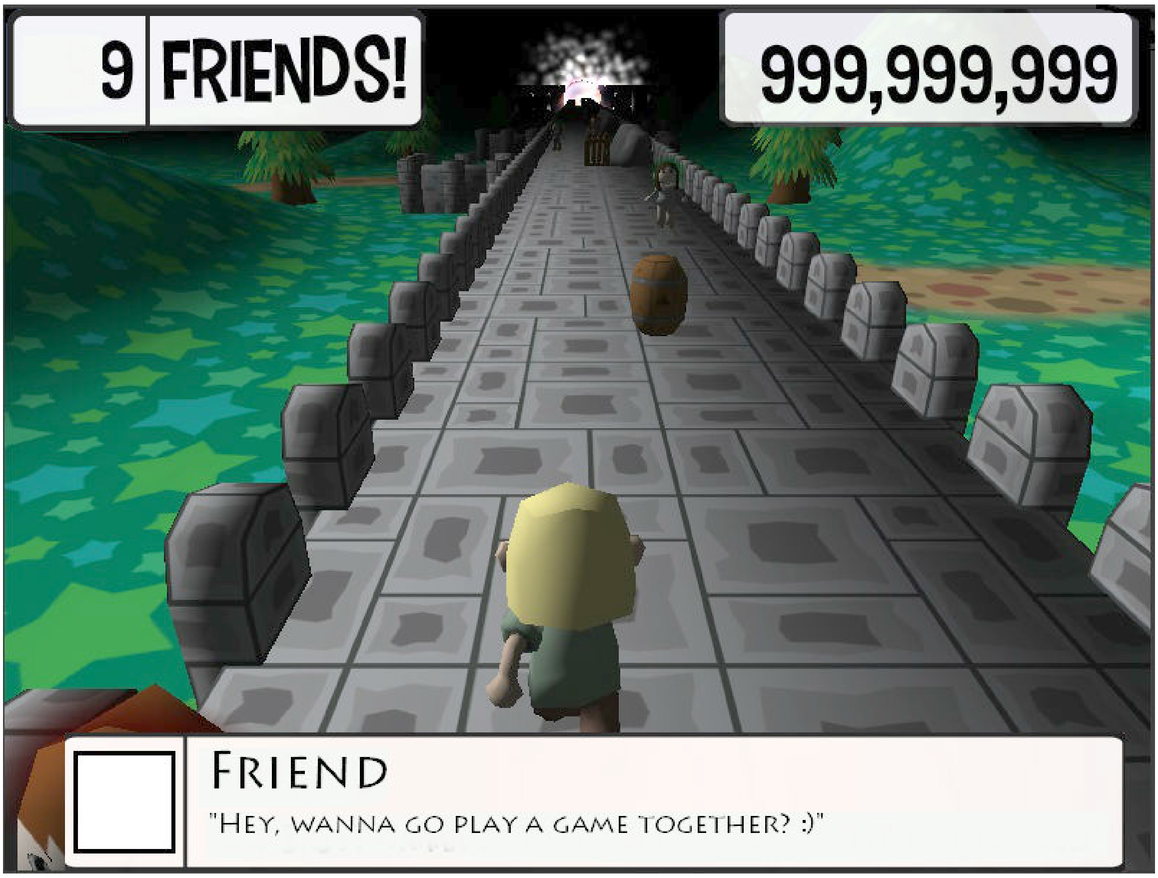
The crafting screen is from the game *Minecraft*, and it illustrates the key elements of the universe (Pillars of Creation from the Eagle nebula, a model of the universe/neuron, a galaxy, a carbon atom, the Earth, a glucose molecule, a super nova, an apple, and the Horsehead nebula) being needed in order to make an apple pie from scratch.

Troll Runner

Carrie Cole and Bryan Novak

Ever run into a troll while playing a game online? If you're a gamer, you know what it's like… if you're playing alone the troll will harass you until you finally snap and leave the game community, but what if you had a team assembled to plow through those trolls? In Troll Runner players can do just that.

Troll Runner is an endless runner set in common gaming communities that trolls inhabit. The player runs through role-playing games, shooter games, and fighting games looking for the perfect game to play. While on their run, the player encounters two types of people. The player gathers a party of friends to join them on their search for the perfect game and they overcome trolls if they have a big enough party to support them. If a player does not have a strong enough support group a troll can overpower them and take away friends.



BioHarmonious

Art Works For Change

BioHarmonious draws the player into a fantasy world whose problems are not so far from home. Giving the Player control of two worlds, whose fates are connected, allows the Player to search for balance. This agency plays on the idea that each person has control in helping change their own planet's fate in the real world. BioHarmonious addresses our collective need to live in environmental balance between the manufactured and the natural worlds.

Surrealist Drawings

V Holeček

I work primarily in colored pencil creating images that fuse the ethereal, the carnal, and the mechanical in an amalgamation of beautiful horror. The three pieces selected and presented for consideration are the most representative of the current direction of my work.

You, A Very Meaningful Game

Lindsay D. Grace

Borrowing from the rhetoric of research on narrative, play and the illusive pursuit of meaningful play, the game takes as its subject you. A character who is backwards, if it not traveling forward. A character that moves playfully, although permanently bound to the awkward limitations of its unmasked pursuit of meaning.

The player must put you in its place. At times, the player must manage you and I in simultaneous concert, in opposition or in cooperation. Each level of the game is about problem solving a space for you to meet objectives while making sense of the in-game content. From this mechanic, the player is both making meaning out of nonsense and finding meaning where it is absent.

The game is organized around the notion of a game poem, where rhetorical device is combined application of narratology and ludology. The game is not designed as serious experience, but instead as a critical experience in meaning making in play.

It is the 10th game in the Critical Gameplay collection, a 4-year project to offer alternative ways to play. The other Critical Gameplay games have been showing on four continents.