

# gls 8.0

CONFERENCE

games + learning + society

JUNE  
2012 13-15

madison, wi

## *Conference* **PROCEEDINGS**

[www.glsconference.org](http://www.glsconference.org)

Edited by Crystle Martin, Amanda Ochsner, and Kurt Squire



**PROCEEDINGS  
GLS 8.0  
GAMES + LEARNING + SOCIETY CONFERENCE**

**MADISON, WISCONSIN  
JUNE 13- 15, 2012**

**Editors**  
Crystle Martin  
Amanda Ochsner  
Kurt Squire

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## PREFACE

This year we are pleased to be publishing the second volume of the annual proceedings for the Games+Learning+Society (GLS) Conference. For eight years now, GLS has been a valued event for individuals working in academia, industry, and as practitioners in schools to come together around their shared interest and passion for videogames and learning. This conference is one of the few destinations where the people who create high-quality digital learning media can gather to discuss and shape what is happening in the field and how the field can serve the public interest. GLS offers an opportunity for in-depth conversation and social networking across diverse disciplines including game studies, education research, learning sciences, industry, government, educational practice, media design, and business.

The GLS conference offers a variety of session types, ranging from traditional academic presentations and symposia to hands-on workshops and informal Fireside Chats with leading individuals in the field. The first day of the conference offered educators a unique opportunity to participate in workshops relating to various topics around games and learning in the GLS Educators Symposium, directed by Remi Holden. Keynote speakers this year included Colleen Macklin, Reed Stevens, and Sebastian Deterding. This year we hosted several Well Played sessions, offering a unique “close reading” of games ranging from *The Elder Scrolls: Skyrim* to *Super Meat Boy*. Introduced by Drew Davidson of Carnegie Mellon University, these analyses enable an opportunity for participants to cross publish in the *Well Played* journal. We also held the first Educational Game Arcade, where attendees were able to play a variety of educational game titles and talk with the developers. This year the conference also hosted the second Games and Art Exhibition titled *Pen and Sword*, curated by GLS artist in residence Arnold Martin. In addition to formal presentations the arcade held lively sessions of games such as *Johann Sebastian Joust*, a social game played with PlayStation Move controllers, as well as the very popular (and sometimes shocking) *Cards Against Humanity*. The informal social and play sessions throughout the conference offer as much opportunity for debate, discussion, and the incubation of new ideas as the more formal sessions and presentations.

We would like to give a big thank you to our conference sponsors this year, including Microsoft Research, Pearson, Filament Games, Mediasite by Sonic Foundry, the Wisconsin Department of Public Instruction, and Game Crafter. We would also like to thank all of the presenters and attendees who make the conference as fantastic as it always is and the volunteers who enable it all to happen. Our last thank you goes to Drew Davidson and ETC Press for publishing the proceedings for us. We are already hard at work on next year’s conference, looking to make it as inspiring and wonderful as ever.

The GLS Proceedings Editors,  
Crystle Martin, Amanda Ochsner and Kurt Squire

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**We want to give a thank you and 1UP to all of the generous individuals who helped us put this year's conference together.**

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And...Shree Durga as Sonic Foundry Liason, with assistance from Shankara Subramanian (Software Development Lead) and Sam Bottoni (Software Engineer)

Moses Wolfenstein as the Hokey-Pokey Guru for the "Put Your Right Foot In" session

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# **LONG PAPERS**



## **Fireside Chats**



# **Let's Talk About Intelligent Tutoring Systems and Games for Learning**

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**Abstract:** There is a growing community of games for learning researchers conducting foundational work on game adaptivity. Their interest lies in the difficulties in ascertaining direct learning gains from instructional digital game play. The common belief is these difficulties arise from a “one-size fits all” approach to instructional game design (Beal et. al., 2002). A potential means to address this issue could lie in the incorporation of artificial intelligence and/or design elements of intelligent tutoring systems within an instructional game’s decision-making architecture. Assessing and adapting to the learner’s instructional needs during gameplay would theoretically result in increased learning gains. This fireside chat will begin with a discussion on the affordances of adaptivity within games for learning. The conversation will then transition to a discussion on the limitations and challenges of implementing adaptive game play, and will conclude with a discussion on future directions in research on adaptivity within games for learning.

## **Introduction**

There is a growing community of games for learning researchers conducting foundational work on game adaptivity. Their interest lies in the difficulties in ascertaining direct learning gains from instructional digital game play. The common belief is these difficulties arise from a “one-size fits all” approach to instructional game design (Beal et. al., 2002). A potential means to address this issue could lie in the incorporation of artificial intelligence and/or design elements of intelligent tutoring systems within an instructional game’s decision-making architecture. Assessing and adapting to the learner’s instructional needs during gameplay would theoretically result in increased learning gains.

This belief is born out of the long-standing challenge within educational technology to provide instruction that adapts to address learner’s individual differences (Thorndike, 1911; Dewey, 1964; Cronbach & Snow, 1977; Como & Snow, 1986; Tobias, 1989). Adaptive instruction, “an educational approach that incorporates alternative procedures and strategies for instruction and resource utilization and has the built-in flexibility to permit students to take various routes to, and amounts of time for, learning” (Wang & Lindvall, 1984, p. 161), is beneficial for several reasons. The first benefit is that adaptive instruction allows for multiple paths to learning and learning goals. The second benefit is adaptive instruction leverages the current aptitudes and skills of the learner in order to strengthen areas of weakness. The third and final benefit is that adaptive instruction better prepares learners to succeed in future learning opportunities (Glaser, 1977).

## **Adaptation Within Education**

Human tutoring is commonly believed to be the most effective form of direct instruction (Bloom, 1984). One reason is the ability of the human tutor to focus their attention on one particular student and tailor the instructional support that they provide. Adapting instruction to meet the current needs of a learner is pointed to as a valuable skill in the arsenal of an effective tutor. Unfortunately, it is logically impossible to provide one-on-one tutoring within contemporary, compulsory school settings. Students greatly outnumber teachers, the finances do not exist to support hiring more teachers, and a host of other issues make it difficult to implement this instructional model. The advent of the personal computer heralded a technological solution to issues surrounding one-to-one instruction. Computers don’t get tired, are always available, are able to make human-like decisions, and can store vast amounts of data, which can be used to provide the dynamic instructional support to learners. One of the more successful attempts at emulating human tutors through the use of a personal computer is an intelligent tutoring system (ITS).

## **Intelligent Tutoring Systems**

The general goal of the field of intelligent tutoring is to increase learning efficiency. These can be conducted through the use of instructional models, which can be one-to-one, many-to-one, or one-to-many models. For example, traditional grouped instruction has one teacher for many learners. One to one instruction is found in tutoring settings. Within a many-to-one model a learner is provided with instruction from a variety teachers that address personal pedagogical needs. Intelligent tutors seek to

take advantage of opportunities provided by computers, the Internet, and the fields of artificial intelligence (AI) and cognitive science to provide one-on-one, many-to-one, and one-to-many learning environments.

Well-designed intelligent tutoring systems have consistently been shown to improve learning outcomes in a variety of different domains. For example, *AnimalWatch*, an intelligent tutor designed to help pre-algebra students solve word problems, produced equivalent learning gains with human tutors, but in half the time (Beal, et. al. 2005). Eliot, Williams, and Woolf (1996) developed an intelligent learning environment to teach medical personnel how to manage the effects of cardiac arrest. An evaluation of the intelligent tutor revealed that it produced results comparable to those produced by a human instructor. Based on these successes within the field of intelligent tutoring (and many more), it is theorized that the integration of an intelligent tutoring systems or cognitive tutor within the architecture of instructional games would help in the acquisition of learning gains.

VanLehn (2006) characterizes an intelligent tutoring system as having two loops: the inner loop and the outer loop. These two loops contain elements that make them an appealing inclusion within the architecture of an instructional game. The outer loop is responsible for selecting tasks for the learner to complete. The inner loop, on the other hand, is responsible for administering the steps that a learner has to complete in order to show competency on a task. In addition, VanLehn states, “the inner loop can give feedback and hints on each step. The inner loop can also assess the student’s evolving competence and update a student model, which is used by the outer loop to select a next task that is appropriate for the student” (VanLehn, 2006, p. 227). By applying these characteristics of within instructional game architecture, one can avoid the one-size-fits-all approach to the sequencing of tasks within instruction and provide an adaptive, personalized learning environment.

## **Adaptive Games for Learning**

Embedding adaptivity within an instructional digital game has several pedagogical advantages. The first is that it allows for personalized feedback. In order to assess the current state of a learner, without interrupting game play, Pierce, Conlan, and Wade (2008) designed the ALIGN (Adaptive Learning In Games through Non-invasion) system architecture. ALIGN is made up of four processes, which work together to provide an individualized learning experience: inference, context accumulation, intervention constraint, and adaptation realization. This system was used to provide feedback and affective support to the user based on their game play. While their study was exploratory, the researchers found those players that received adaptive hints after an unsuccessful experience within the game showed marked improvement on future attempts on the same task than those who played a one-size-fits all version of the same game.

Another affordance of adaptive digital games for learning is the adjusting of the game style to the learner. Magerko, (2011) describes S.C.R.U.B. (Super Covert Removal of Unwanted Bacteria), which is a game being developed to teach about microbes that are resistant to antibacterials and their transmission within a hospital setting. S.C.R.U.B. is actually a collection of small (mini) games that are being designed to teach students about these super strong strains of microbes and how they can be transmitted from person to person from either contact with contaminated surfaces or human-to-human contact. Adaptation of the game takes place through the matching of the users play style preference to their learning style preference. While this adaptation is not dynamic (play and learning style preferences are determined by a pre-test), the researchers have developed a prototype, with the ultimate goal being dynamic game adaptation.

Goetschalckx et al. (2010) condensed adaptations within instructional digital games to two categories: Dynamic Difficulty Adjustment and Dynamical Estimation of Player Abilities. One important characteristic of games is their ability to provide challenge. AI can be used within instructional digital games to provide the appropriate amount of challenge to a user. This is accomplished through the creation of a player model. Challenge is an important element of successful game design as it serves to maintain motivation and engagement, which are important contributors to learning. AI is a beneficial addition to the architecture of any digital game because when tuned precisely, it can provide the optimal level of challenge, while providing the learner with the exact instructional content that is needed.

## Intelligent Tutoring Systems and Games

Attempts at combining features of intelligent tutor systems with features of games can be classified in one of three approaches: 1) Adding game features to an existing ITS, 2) adding ITS features to an existing game, and 3) building a combined ITS and game. An example of the first technique would be the incorporation of game features within *Grockit* (Bader-Natal, 2009), an online intelligent tutor designed to prepare students for the Graduate Management Admission Test (GMAT) and the Scholastic Aptitude Test (SAT). *Grockit* (Bader-Natal, 2009) sought to leverage pedagogical affordances of specific game features in an attempt to encourage synchronous collaboration between tutees. This interaction between tutees was deemed beneficial because it provided a solution to the problem of correcting misconceptions of learners by allowing other tutees to remediate. In order to facilitate this correction of misconceptions through peer remediation, *Grockit* allowed tutees with similar interests to form learning communities where they worked with peers with similar interests on study problems. Within learning communities, tutees could play games designed around answering exam questions. Within the game, all tutees were presented with the same question, which they were all required to answer. Once all participants had answered the question, they were provided with the correct answer and allowed an opportunity to discuss the question and the answer. Within the main lobby of the learning community, tutees received feedback through the game features of points, performance statistics, leaderboards, and badges.

An example of the second technique of adding ITS features to an existing game would be *River City* (Nelson, 2007). *River City* is multi-user virtual environment in which learners are placed in a 19<sup>th</sup> century town and tasked with determining why residents are getting sick. In order to gather evidence players can talk to other three-dimensional agents within the world, read books, and collect and analyze samples. All of the information that players feel is important can be kept in a logbook. *River City*'s instructional purpose is to provide an environment in which players can increase their scientific inquiry skills while also learning about bacteria. The investigator sought to explore the effect of adding an individualized guidance system within *River City* in order to increase learning gains. The individualized guidance system was designed based on adding features of ITS. An expert modeling and coaching system was integrated, which demonstrated to players the proper way to conduct an inquiry and answer questions within *River City*. This ITS feature is akin to the feature set one would find in a step-based ITS. In addition to the expert modeling and coaching system, a part-to-whole ITS trainer called the Legitimate Peripheral Participation System was designed to guide the players through inquiry tasks by assigning specific tasks and systematically increasing the responsibility of players in gathering evidence. While no significant differences were found between those who played the ITS enhanced version of *River City* and those who didn't, there were significant differences found between participants based on gender in terms of learning outcomes.

Finally, the third technique of building a combined ITS and game was explored by Rowe et al. (2009) within a game called *Crystal Island*. *Crystal Island* has a similar instructional objective as *River City*, with the main differences being the inclusion of intelligent agents, which have tutorial and narrative orientations, and a focus on pathogens versus bacteria. The intelligent agents in the game were constructed to provide affective instructional support by attempting to display empathy to the learner. An additional difference between *River City* and *Crystal Island* is that *Crystal Island* has more structured learning activities, while *River City* was built based on a theoretical framework of socio-constructive and situated cognition. In an investigation of the impact of *Crystal Island* in terms of providing affective support to learners, *Crystal Island* outperformed the control condition in providing affective instructional support, but no significant differences were found between the control condition and affective condition in increasing learning gains.

There seems to exist potential for the adaptation of instructional game play based on an estimation of the abilities of the player and their affective state (based on observable and unobservable variables, expert model, learner model, etc.). This would buck the trend of one-size-fits-all instructional games by providing a personalized learning environment that is optimally tuned to address the current learning needs of a student. This approach to games for learning design is definitely in its infancy, but is definitely an area worthy of investigation. This discussion will serve as another contributor to the growth of the field by providing a forum to discuss past successes, current projects, and future directions.

This fireside chat will begin with a discussion on the affordances of adaptivity within games for learning. At this point the conversation will shift to a discussion of the three approaches to marrying

intelligent tutoring systems and games. Specifically we will discuss approaches to integrate ITS goals and game goals. Furthermore, we will discuss the instructional domains and game genres which lend themselves to a marriage between ITS and games. The conversation will then transition to a discussion on the limitations and challenges of implementing adaptive game play, and will conclude with a discussion on future directions in research on adaptivity within games for learning.

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# Just Press Play: Design Implications for Gamifying the Undergraduate Experience

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**Abstract:** Whether demonized or lauded, gamification is a new direction that corporations and institutions are using to engage their target base. The Just Press Play (JPP) Project, developed by the Rochester Institute of Technology with funding from Microsoft Research is one of the first serious attempts at gamifying the undergraduate experience. If successful, the tools and methods used in this project will be made available to other organizations for their own implementations. This talk will address the design aspects of the project, the implications of gamifying the college experience, how the design of JPP can model a new direction for student engagement, and what the implications of this project are in the larger discussion of mapping game-like layers in “serious” contexts.

Gamification is a highly debated issue in games-based research. Those who profess the virtues of gamification speak of the benefits when people play or learn towards a common interest (McGonigal, 2011). In contrast, critics believe that gamification is being used as a marketing ploy for the benefit of the corporate sponsor rather than the participant, going as far as to try to rename gamification to exploitationware (Bogost, 2011; Juul, 2011). Regardless of your side in this debate, however, gamification in its current form does not seem to be declining in popularity. On the contrary, the idea of layering game-like elements onto real-world spaces and practices is flourishing. From Nike+ helping motivate runners to Foursquare declaring mayors of McDonalds, gamified spaces are indeed changing the way we are looking at games and our interaction with the world around us. Yet few of these experiences have been designed for the environment where numbers, achievement, and assessment matter the most—that of education.

The Just Press Play (JPP) project is an attempt to shape the way undergraduate students approach their academic careers. JPP is a game layer added onto the academic space, developing challenges for participants to achieve and help establish another outlet where academic staff and students can communicate besides just the classroom. The “players” of JPP are presented with a series of challenges that range from going to the instructor’s office hours to dining off-campus with a large group of classmates. Once a challenge has been completed, the player receives an achievement, which they then claim and display to other students. The website where the players go to submit their achievements is accessible only to the players of JPP, fostering a close community. As of the time of writing this paper, the JPP project has over 500 participants.

Many educational games are set up for failure because they want to cram as much academic content into the product as possible. What makes JPP unique is that while they are gamifying the academic experience for the students in the Interactive Games & Media (IGM) program, they want to stay away from academic-specific content and focus more on the community itself. Their achievements are guided by three questions: What behaviors did we want to reward and encourage? What feelings of competence could we engender? What did we want our students to remember and reflect on?

This paper will discuss those design strategies behind JPP and the iterative process of its creation. Through interviews with both students and faculty both behind the scenes and with users of JPP, assessment researchers from the University of Wisconsin-Madison discovered a densely layered process of iteration and best practices, as well as some of the drawbacks and design flaws to act as a learning lesson for those wishing to add gameful layers to their own environments. We hope to make JPP a part of the larger discussion on gamification but especially in an academic setting so as to highlight some of the advances of the JPP model and drawbacks to porting what happens at RIT to other environments.

Games have been consistently shown to be well-designed learning environments (Gee, 2005; Squire, 2006). Evidence already supports the usefulness of games as a supplement to the curriculum (Squire, 2004; Egenfeldt-Nielsen, 2004, 2006, 2007), a standalone educational experience (Barab Hay, Barnett & Squire, 2001; Barab, Thomas, Dodge, Carteaux & Tuzin, 2005), and a way in which a community can deliberate scientific concepts (Steinkuehler & Duncan, 2008). But these successes are predicated on the games being well designed for their purpose. Good design of educational games is particularly critical, because their failure risks setting back the general pursuit of using games in schools. If the game or educational tool is too complex for even the teachers, the students will suffer (Tuzun, 2007; Halverson, Shaffer, Squire & Steinkuehler, 2006).

What JPP wants to eventually accomplish is therefore incredibly ambitious. As their website states:

It is our hope that future funding will allow us to bring the Just Press Play experience to a larger audience, both at RIT and at other institutions. Towards that end, our underlying infrastructure will eventually be made available as an open source project (Just Press Play, 2011).

The scope of JPP requires a design specific enough to focus on the needs of students in an educational program, but general enough to be able to be customized for other environments moving forward. The question then becomes what will stay or go in the final design that does become publicly available. One of the first systems designed was JPP's achievement system.

The achievement system in JPP assigns achievements to the user when he or she completes a task. Like many games, the beginning of JPP offers a low buy-in for the player. Simply visiting a faculty or staff member will earn you a tutorial-level achievement. It is at this point that the user could become more invested, as the goal of the developers of JPP is to make the student more engaged with their own education (Lawley & Phelps, 2011). But is there a need to gamify the student's collegiate experience? Do we cheapen the process of taking charge and remaining proactive in your career by narrowing down achievement to earning achievements? Deci (1971) found that extrinsic rewards through gold stars and other physical forms of accomplishment actually decreased intrinsic motivation, later confirmed through a meta-analysis (Deci, Koester & Ryan, 1999).

The answer that the developers of JPP came up with and could be the reason why the game still remains a topic of interest with the students is that there is no achievement tied to the curriculum. As a senior developer on the project put it, "if they [students] felt coerced into doing it [JPP], we lose, it's broken" (N1, 2012). The students who remain in the game do so because of the intrinsic motivation of wanting to fulfill achievements, and not for any extrinsic motivation tied directly to the IGM curriculum.

The developers wanted to design a game that would not make the students better scholastically, necessarily, but better all-around students. There are achievements that include simply getting to know the professors in your department. One such achievement, "For the Lawls" was to tell a joke to a senior professor and if she laughed you would receive that achievement. Another achievement dealt with rifling through a visiting professor's office to find his card while he was present. There were many achievements that allowed you to get to know your faculty, but there was also in the design ways in which you would socially interact with people in your department where before you may have not had, or made, the opportunity.

Undying achievements or large-scale events intended to allow social interaction amongst the larger IGM community have proven to both be well-placed achievements for interactivity and social engagement. From our interviews, participants would frequently cite the flash mobs and the Study Club achievements as being their favorite activities.

The flash mobs are initially devised by one faculty member who also is in charge of the achievement artwork and then collaborated upon by the other faculty behind JPP. One of the flashmobs was a rendition of the famous dance from the Michael Jackson song Thriller. Another had to do with a human Rube Goldberg machine, taking place in the atrium of the building which houses IGM. While both activities took place on school grounds and were run by faculty and staff, these achievements were not tied to curriculum in any way.

The Study Club achievement is the closest JPP ever gets to being tied to a curriculum. At RIT there is a computer programming course for which the pass rate stays at a consistent percentage throughout the iterations. Seniors got together to help the freshman study for the final exam and while we cannot

prove causation, the semester the achievement was implemented, the pass rate went up by several points (N1, 2012). What was supposed to be a one-time achievement became a recurring one not because of academic success, but because the students felt they were making a positive influence on their peers with the study groups. While these are great examples of how to add gameful layers to the college experience without covering the broccoli in chocolate, there have also been lessons learned from this experience for others looking to do something like JPP in their own institutions.

As stated previously, the achievements of JPP were not motivated to help students do better in classes or reward them for those efforts, but rather to generate a sense of community and highlight the many resources at the students' disposal at RIT. A two-year process from conception to launch took place involving the advice from experts in the games-based learning field and through funding from Microsoft Research. Because maintaining JPP would require funding for staff and resources, little progress on the infrastructure end was made until funding was guaranteed. When the funding came through, staff and students had a little over 3 months till their proposed September launch date, the start of the RIT school year. A decision was made to push back the launch till Homecoming, but even with an extension of time, developing as complex a tracking system has JPP was envisioned to be is still a near impossible task.

With a system as broad as JPP where students are to have an online database where they can log their achievements and compare with others in the game, it involves a lot more than just game design to make the whole system work. The work of JPP was therefore split into two groups: game design (achievements & fun factor) and the technology end (infrastructure, system stability, aesthetics, and information dispersal).

The game design of JPP took on various evolutionary stages from what it currently is today. At first, the achievement system was loosely based on Bartle's player model test (Bartle, 1996), but was challenged by a senior advisor and subsequently removed because of the incompatibility between overlapping an achievement system onto a system of player types. Instead of shoehorning achievements into player types, and design and development, the developers wanted to focus on breadth and depth of achievements to attract the largest possible audience, encompassing all types of players without relying on Bartle's player types.

RIT has the luxury of having a historically rich backstory to its inception, one which developers wanted to incorporate into the storyline behind JPP. What is now known as RIT used to be the Rochester Athenaeum, a liberal arts school, with the other school being the Mechanics Institute. Again alluding to how the developers wanted to shy away from curriculum specific content, many achievements have to do with the initially dichotomous relationship between the two schools. The historical element of JPP encompasses only a fraction of the total achievements, and with any good system there is a potential of leveling. The project itself may have become so popular however, that the infrastructure and achievements made were not enough to withstand the demands of the participants.

The initial launch of JPP was to involve a comprehensive website with RFID tags so that students would be able to register achievements at kiosks. The physical placement of RFID scanners was too much for the infrastructure to accommodate, and therefore, the RFID tags are still underused. The information resources of JPP, which include Facebook groups, online newsletters, and subreddit threads, were also underutilized, as the interviewees rarely used these resources. In addition, despite the research that speaks negatively of extrinsic rewards, the interviewees actually felt this would help participation in the program either because of workload or perceived exclusion:

"There could be better ways to incentivize it (JPP), because right now it's kind of an intrinsic incentive...the incentive is the achievements themselves...I know that at least for people like me...it works as a system...there are a lot of people I know that would need some sort of a push or something tangible to actually want to participate." (N2, 2012)

From our preliminary statistical analysis, participation has dropped dramatically since the launch, but from the interviews it is not from lack of interest in the game, but rather a lack of content. The concept of JPP, like other massively multiplayer online games, was to have participants level up based on their achievements in the game. Unfortunately, many of the players became so engaged that those who played all of the content for leveling up did so in just a few weeks. Content has not been added in

the additional levels, and therefore those players have been put in a waiting pattern. No participants in interviews who played signaled they would stop playing once a new update of JPP is released.

Although there are difficulties with JPP in regards to additional content and the potential to exclude some audiences, what the game has managed to accomplish is attracting a devoted audience who, while acknowledging the faults of the project, also look forward to the revisions. There could be several reasons for this, such as the uniqueness of the program geared towards game design or the devotion given to certain faculty who are in on the project, but what has been accomplished should not be lessened because of flaws in the infrastructure. Those who are playing at the moment are enjoying the game, and while JPP's system should not be made available open source just yet, they avoid many of the pitfalls of other gamified environments which rule out their usage completely.

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# Designing a Game Based Approach to Tobacco Abstinence

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**Abstract:** Smoking relapse remains a significant public health concern with high costs. Behavioral rehearsal can help smokers master coping skills to manage smoking urges. A collaborative team of doctors at Memorial Sloan Kettering Cancer Center and game designers at Muzzy Lane software have been exploring the potential of a game-based approach to this challenge, focusing on post-operative cancer patients who need support to avoid resuming smoking when returning home.

The team has developed multiple game prototypes, and tested these prototypes with our target audience and expert reviewers. Both the design and testing have yielded unexpected insights: Because much of the work of smoking abstinence is internal, we developed game mechanics for “internal dialog” that work alongside other mechanics for conversation, and that allow players to practice a variety of coping skills. We will report on what we have learned in Phase 1 of the project, and what next steps will be in this ongoing project.

## Significance

This project's aim is the development of a smoking urges coping skills game to decrease post-hospitalization smoking relapse in tobacco dependent cancer patients. This remains a highly significant project for several reasons. While effective treatments for tobacco cessation do exist, relapse rates remain high and innovative interventions specifically designed to prevent relapse are needed.

Our team started with the idea that a coping-skills game could offer several advantages to traditional behavioral treatment: It can be practiced multiple times at smokers' convenience to address their specific smoking triggers; It can create realistic simulations that provide behavioral rehearsal opportunities that are not possible in real-world treatment settings (e.g. social smoking situations); it can be readily disseminated to a broad audience of tobacco-dependent patients without resource-intensive programs; and it can be cost-effective as the initial outlay of costs can be recouped with wide access and re-use.

## Project Overview

Supported by a NIDA grant, we have undertaken a design-research project to develop and test a series of prototypes, with initial aim of arriving at the game mechanics that have the greatest potential for success.

We have created two prototypes, and tested them with a population of medically ill smokers. In this paper, we report on the findings from both the design work and the testing. Results from the early prototyping resulted in the ‘invention’ of new mechanics—and testing results showed both promise and work to be done. We plan in the next phase of the project to complete a third version of the game, building on what we have learned, and then do a randomized clinical trial design (Usual Care + Smoking Cues Coping Skills Game vs. Usual Care Only) to test whether the game increases coping self-efficacy and smoking abstinence among hospitalized cancer patients.

## Design Research Work

Design and development has been a collaborative process with the two PIs leading individual teams at MSKCC and at Muzzy Lane Software. The team began work with discussions of earlier research by our medical team, and of a wide array of game mechanics and approaches that we might draw upon.

We then developed an initial design approach over the next month. It included a key concept based on patient profile discussions: Patients would not play “themselves”—instead, the game would feature one or more relatable characters in situations that would present challenging situations within which to practice coping strategies for managing smoking urges.

Based on this design direction, a non-electronic prototype was produced (using board-game metaphors) to allow the team to review the concepts and gameplay with the Patient Advisory Group (PAG), which met on May 11 at MSKCC. At the PAG session, the team received valuable feedback that led us to finalize several key aspects of the Phase I design. The key feedback points were:

- Patients did not want to be presented with a game that depicted smoking cessation as “lightweight or tried hard to be entertaining” (a PAG member). The PAG member commented that he would be interested in learning from the serious struggles of his and others’ quitting experiences.
- Patients appreciated the narrative element of the paper prototype, and were inspired to tell their own stories in response. This solidified our belief that the narrative would be important for our target population.
- The group highlighted the importance of their internal struggle to cope with urges to smoke, which were seen as more important than external (environmental) triggers. For them, the struggle went on largely in their heads. We realized we needed a way to incorporate this element into a key design innovation, which became known as Internal Dialog.

### **Updated game design based on paper-prototype feedback**

To address the issues raised during the PAG meeting, the team devised several key design innovations and made a variety of decisions in the planned product structure. We believe these design changes will greatly increase the impact of our planned Phase II product. The changes were:

- **Internal dialog system:** This system gives the player control of the game avatars’ thoughts, as well as their conversation and actions.
- **Counter-thoughts coping mechanism:** As part of the internal-dialog system, we were able to model the concept of counter-thoughts that the player/avatar can use to count negative (tempting) thoughts about smoking.
- **Challenges:** Organize the game as a series of 10-15 “Challenges” rather than one “Game”.
- **Multiple characters:** Include three different characters in order to give a wider range of characters to which patients can relate. We also plan to have the narratives of the characters connect with each other to sustain motivation and propel patients to play new “challenge” situations.

### **Development of the Smoking Cessation Game Prototype**

Once the product and game design were reviewed and approved by the full ML and MSKCC teams, we specified the subset of the full product that would be produced as a prototype for testing. We specified that the prototype would include:

- One complete “Challenge” or unit from the fully envisioned product, with all the features and functionality we would expect a unit to include. This included a 3D game scene with three characters working through one challenging situation.
- An initial project website from which the Challenge could be played. The website would also provide a menu of additional envisioned challenges and project and character descriptions to give PAG reviewers necessary background for playing the game.

### **Character and environment design**

The characters and environments needed to meet several challenging criteria: We wanted environments to be somewhat realistic, but also environments that patients would be willing to spend time in virtually.

We also wanted the environment to be relatable: We had learned from earlier interviews that patients were more willing to fully enter the experience if they felt it related to their own struggles as smokers.

Characters needed also to be sympathetic to the patients from a broad range of social and ethnic backgrounds. Characters were designed to have a solidity and straightforward naturalism, while NOT being realistic in detail. We wanted to avoid the “uncanny valley” of characters that are a little too realistic, and therefore end up being off-putting, as viewers compare them to reality and find them wrong.

## Narrative Writing

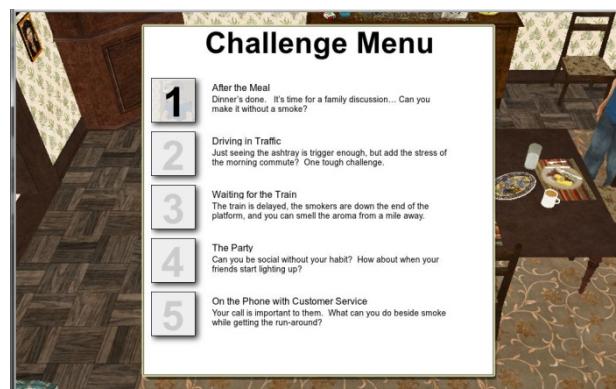
Since we understood that narrative would be an important part of the project, we added an experienced play and television scriptwriter, to the team. He has written for the stage, for public television, and is currently an artist/writer in residence at MIT. His scripts and dialog were praised by testers as both feeling “real”, capturing the challenges patients faced, and adding some appropriate humor. With the addition of Internal Dialog (along with Conversation and Coping Actions), we needed to develop a new format for our scriptwriting, which will be useful going forward.

## The Second Prototype

The second Prototype was completed in July and deployed to the project website and tested internally at MSKCC in preparation for review and testing with patient volunteers. The following captured images show the major elements of the Prototype:

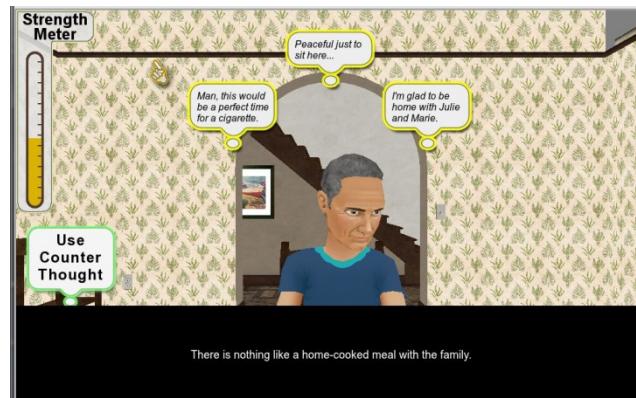
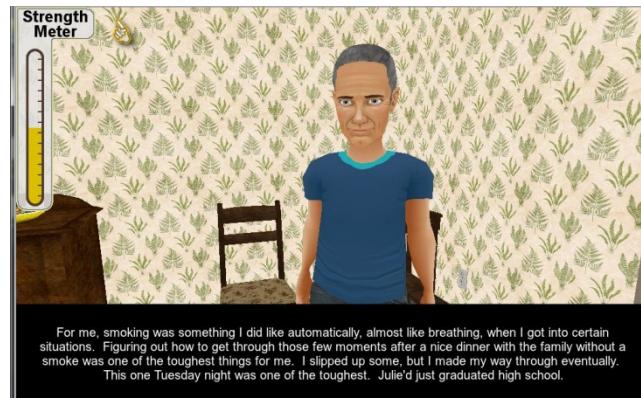
### Screens from the Prototype

The following screens show the main elements of the second Prototype:



**Game characters:** Patients will choose from three or more characters. The prototype featured this character.

**Challenge menu:** Patients will choose from 15 challenges in final product. Prototype included one challenge.



The character (Ray) introduces the Challenge.

**Interior Dialog:** The patient can choose what Ray thinks next. Patient can also use Counter Thought to neutralize a negative “trigger” thought.



**Conversations:** The patient engages in the situation by controlling conversation with other characters in the scene.

Coping strategies for managing smoking urges: The environment also includes a variety of coping strategies the patient can utilize and practice—in this case, petting the cat.



**Slipping:** If the character (Ray)'s strength (to resist urges) is reduced to zero, Ray slips and smokes. This outcome is what the player is working to prevent.



**Post slip:** The participant can practice ways to recover from a slip—in this case through dialog.

## Expert Panel Review and Feedback

We conducted interviews to introduce the game and solicit feedback on the prototype from five external consultants with expertise in the development and evaluation of tobacco cessation interventions. These consultants were provided with off-site access to the prototype game and were requested to provide specific feedback on the game relevance, usability, and utility. Overall, the experts found the game to be engaging, novel, and appreciated the value and appeal of the narrative story for player engagement. The following four primary themes and suggestions emerged from the Expert Panel:

**Add a clear and compelling initial orientation providing goals.** The experts recognized that our intended users are not experienced game players and therefore suggested that greater attention be paid to “setting the stage”, and framing the game as intended to be a helpful way of practicing ways to manage challenges faced by smokers in their efforts to become smoke-free.

**The user interface will benefit from more explicit instructions for manipulating the game environment.** Similarly, the experts perceived that less experienced game players might find it difficult to engage the interactive elements of the game environment and suggested that a narrator and/or “help” icon could help players navigate and manipulate the game environment. Although they liked the overall concept of selecting and being encouraged to use Counter Thoughts as coping strategies, this was one formatting element in which the experts felt that either a demonstration or explicit coaching from a narrator would be needed.

**The avatar should allow a broad range of patients to identify with the game characters.**

There was a lengthy discussion about whether players should play themselves or a game character. One expert suggested that being able to build, select and personalize the “look and feel” of the avatar is a fun way to increase players’ game engagement. All agreed that having choices with regard to character selection and options for play enhance relevance. Additional suggestions included more reference to the cancer and its treatment.

**Experts provided suggestions for making the game more engaging by providing greater reinforcement for positive or negative game decisions.**

Several comments focused on improving the ways in which we presented the rise and fall of the player’s “urge to smoke.” One expert suggested adding more explicit praise and encouragement for constructive use of coping strategies (“the narrator could praise players for effective coping”). Another expert suggested that effective use of coping strategies be reinforced with evidence of the character having powered-up (acquired some wisdom or mastery of coping strategy).

## Patient Feedback

As planned, we recruited 20 game tester volunteers who were adult cancer patients treated by the MSKCC Tobacco Cessation Program. Interested patients were scheduled to evaluate the game at the MSKCC Communication Skills Training Laboratory, where there are suitable digital media facilities for demonstrating and recording a participant’s interaction with the web-based computer game. Informed consent was obtained. Dr. Krebs conducted all patient feedback sessions. As testers navigated the game, we used a “think aloud” or “verbal protocol” approach, which is recommended for usability testing.

Participants were encouraged to verbalize their thoughts and raise questions as they explored the game. Testers provided feedback on the introduction, proposed character descriptions, and played through the prototype of an after-dinner scene with the avatar Ray and his family. Following completion of the scene, patients were asked a series of evaluative questions. Usability was assessed with the 10-item System Usability Scale (SUS), which has been found to have excellent reliability in assessing usability of computer systems. The SUS is scored on a scale of 1-100 with two subscales: Usability and Learnability.

As planned, patients represented a wide range of ages from 31 to 74 years, with a mean age of 56. Participants were 70% female, 35% identified as African American and 5% as Hispanic. Current smokers comprised 65% of the sample, and breast (40%), lung (20%), colon (10%), and prostate (10%) were the most common cancer diagnoses. 30% did not use a computer even occasionally and 80% had little or no prior use of computer games.

The testing items evaluated four domains: User Interface, Content, Overall Experience, and Usability. User interface, as defined by ability to figure out how to play the game, understand the instructions and text, knowing what a user is supposed to do, comfort in playing the game, and professionalism were rated at a moderate to high level, with means on a 5-point Likert scale ranging from 3.00 to 4.65.

Content items assessed the game’s utility in helping users manage smoking urges ( $M=2.90$ ), prevent relapse ( $M=3.65$ ), and apply content to their own lives. Patients rated content relevance at a moderate to high level ( $M=4.10$ ). In terms of their game experience, patients reported moderate to high satisfaction ( $M=3.75$ ), would strongly recommend it to other patients ( $M=4.70$ ), and felt that it kept their attention ( $M=3.50$ ). The Usability Scale (1-100) summary score was moderate to high ( $M=67.00$ ), a similar level observed with other commercial computer systems. The Usability subscale mean was ( $M=65.94$ ) with high Learnability ( $M=71.24$ ). Finally, responses from open-ended questions and patient comments were transcribed and thematically coded.

Six primary themes emerged from the qualitative feedback:

***The user interface was easy to use once instructions regarding game play were provided.***

Patients described that it was easy “after initial guidance” and that the “meter going up meant I was doing well.” On the other hand, patients said “instructions needed to be more explicit” and that it was “sometimes confusing about what to do with the character.”

## **Patient experience with the user interface provides important data for a full game version.**

In the first sessions, we did not provide explicit instructions either within the context of the game or by the tester; we wanted to test to what extent the game should have explicit instructions versus a concept where patients discover the rules for themselves. It became clear that our completed version will require the game to begin with a demonstration and orientation. The simple clickable user interface succeeded in making the game accessible in that as soon as patients were given a brief introduction by the tester, even patients who never before had used a computer were able to play it easily.

## **Patients strongly identified with the smoking-related situations and struggle to remain smoke-free.**

When asked what they liked most about the game, patients strongly affirmed the authenticity of the after dinner scene in which they play the avatar, Ray, and choose his thoughts and dialogue. For instance, in terms of relating to the avatar, patients said, "I knew what he was going through. I related to the situations", and "I related to Ray; I was feeling everything he was feeling."

In designing a method for introducing users to smoking-related situations, we decided that users would play characters with partially-scripted scenes, rather than playing an avatar representing themselves in an open-ended scenario. The goal of this design choice was to make game play easy for novice users as well as to enable the game to introduce patients into common scenarios with which smokers struggle. Testing revealed that patients strongly identified with the character and dialogue of the situation; no patient stated that he or she would rather have played an avatar representing him or herself. Testers responded that:

- "I found myself projecting a lot"
- "There were enough choices to pick to match my own thoughts"
- "The thought choices were "spot on with what you'd say to yourself"
- Testers liked "trying to put myself in Ray's shoes and make the best choices in a positive way."

## **The process of game play demonstrated both behavioral and cognitive coping skills for remaining smoke-free.**

The game demonstrated cognitive coping skills by requiring users to choose Ray's thoughts and dialogue, which then influenced how the other characters responded to him. Behavioral skills were exemplified by enabling the character to choose strategies such as drinking water or deep breathing to cope with tempting situations.

Patient-testers responded that the game play was useful for teaching and reinforcing coping skills:

- "I like that I was brought along as the character, since it introduced me to new ideas about how to not smoke."
- In terms of what they will integrate into their own lives, patients reported: "to be mindful of thoughts and that you can stop yourself."
- To pause and make a choice, "I learned substitution, distraction, and avoiding cues that would make you want to smoke", showed me "I can do without and walk away," and that one tester found it helpful "...that you could make choices because that's a big part of quitting."

Our goal in design was also to show the mutual influence of the characters on each other. Testers readily picked up on this concept:

- "As he made choices, he received positive responses from his wife and daughter. His reactions shaped the outcomes."
- "That it's a bit like a real conversation in that you're not in control of how others in game react."
- "[The game] shows you how not to escalate situations and make things worse."
- "Communicates the importance of communication." "It's okay to ask somebody to go outside" and "Shows you it's not a singular fight; it involves everyone around you."

### **Patient-testers made suggestions for broadening the characters' diversity, adding coping situations, and for reflecting their own experiences with cancer.**

We had populated the prototype dining room with a small sampling of coping strategies in which Ray could engage. While patients identified with these, they also made suggestions for additional strategies:

- “He needs to be able to do more things.” Patients suggested puzzles, reading, going outside, exercising, doing artwork, praying, and clearing dishes.
- In more than one instance, patients noted a desire for more specific reference to cancer: “Choices for dialogue should reference cancer and recovery” that it should emphasize “Consequences of smoking such as recurrence”.

Creating a game that reflects and appeals to a diverse audience is an important goal of our project. Our testing sample was 40% non-Caucasian and 70% female, and thus well-represented in terms of diversity. Patient-testers expressed desire for: a “Female character in a management job”, that it needed a “dark-skinned character” and that we should “Add more races and realistic situations for those races.”

### **Testers noted suggestions for making the game more fun and fast-paced.**

While patients found the game interesting and engaging, they also expressed desire for it to have more elements of fun. Patients stated it “Would have to be more exciting”, and that Ray was a “glum character.” In line with typical expectations of a game, testers also wanted a reward structure:

- “I wanted a reward. I wanted it to keep score”, and that “winning reinforces positive coping.”
- Patients wanted the action to move along more quickly, finding that there were “too many thought choices at start” and that “all the choices slowed you down” and “took too long to read.”

### **The game offers strong potential to be useful for preventing relapse.**

In their summary comments, patients remarked that the game:

- “Reinforced tools and strategies I learned”, that it would “help me in situations where I have a pattern and see it differently”, it could “be a reminder, sometimes good reminder of choices and dealing with people who smoke” and that “if I’m slipping, it’s a good reminder, feels motivating.”
- Participants also liked the computer model in that “interactive is the way people are going to be taught”, and “I was fascinated because I’ve never seen anything like it.” Overall, it is “an excellent idea. Needs to be fine-tuned though”, that “you’ve struck gold” and that it was “well thought out.”

### **Conclusions and next steps**

This Phase 1 of the project has been highly valuable—lessons have been learned that will be invaluable in the second phase. Designing an effective game-based approach to a difficult, personal challenge like smoking-cessation requires both strong game design (in providing strong goals, rewards, good feedback, and interesting mechanics), and consideration of other issues:

- Because of the personal and truly life-and-death nature of the problem, patients/players are very sensitive to both the context of the game world and the authenticity of the characters:
  - Patients do not want to feel that the struggle is in any way trivialized.
  - Patients want the experience to feel grounded—to have a weight that matches the seriousness of their own struggle.
  - Characters must mix relatability and gravitas—their challenges must be believable and non-trivializing.
- Very simple and focused interfaces and mechanics are needed: This audience is often not familiar with standard interfaces and concepts of computer games, and does not easily see and absorb the multiple streams of information (scoring, meters, character action, dialog, etc.) that games can provide.
- Internal Dialog mechanics can work, but issues of complexity and sequence must be worked out: The players identified with the thoughts, and immersed themselves in the challenging situation of the character, and did in fact “practice in context”. But they were confused by some active-thought mechanics like Coping Thoughts.

We look forward to addressing these issues in a new version of the game, and to the opportunity to run clinical trials to test that version.

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## **Hall of Failure**



# **When Simple Is Not Best: Issues that Arose Using Why Reef in the Conservation Connection Digital Learning Program**

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**Abstract:** Employing a combination of web-casting, vlogging, virtual world simulations, and social networking, The Field Museum connected American and Fijian teens interested in environmental conservation through an after-school program entitled Conservation Connection. Participating teens learned reef biology, increased their digital literacy, and produced plans for sustainable management of reefs. A key component was a 2D coral reef simulation on Whyville.net—*WhyReef*. We envisioned that *WhyReef* would serve as an interesting and age-appropriate platform through which teens would develop a common knowledge base about coral reefs. Additionally, we believed that banners, advertisements, and virtual money incentives would motivate lurkers on *WhyReef* to take interest in Conservation Connection and participate via the social network. Our observations and interviews indicated that *WhyReef* was too simplistic to engage non-Whyvillian teens. Furthermore, *WhyReef* did not succeed in incentivizing lurkers to participate. We attribute this low participation to perceived exclusivity, program timing, and access to technologies.

## **Introduction**

Biodiversity loss and species extinction are approaching, or may have already reached, a critical moment. Many scientists agree that the Earth is experiencing its 6th mass extinction; though unlike previous extinctions, this one is caused by human activity (Human Footprint too Big for Nature, 2006; Mittermeier, 2011). Coral reefs are hotspots for biodiversity but are in imminent danger. For example, there are currently 845 known species of reef-building coral and of that number, 231 species (almost one-third) are facing extinction (Black, 2008).

Natural history museums and other informal learning institutions can use their frequent interaction with the public and their status as trusted sources to impact both science education and awareness of the biodiversity crisis (Drew, 2011). Digital learning programs for youth at The Field Museum of Natural History (FMNH) aim to introduce the tools, such as critical thinking and problem-solving, necessary to understand the consequences of biodiversity loss, and engage youth in the global connections between species survival, biodiversity, conservation, and human communities. FMNH developed Conservation Connection (ConConn) to engage youth, aged 13-18, in the stewardship of coral reefs using the cross-location, collaborative problem-solving necessary to affect change. FMNH partnered with a high school within the Chicago Public School District and a high school in Suva, Fiji to create a core team of teens, separated by geography but working together towards a common goal. Additionally, FMNH reached out to youth on Whyville.net, specifically those interested in marine conservation, to join the ConConn community and aid in reaching the program's conservation goals.

While the program had many successes, the project team also experienced a key failure. A central component of ConConn was *WhyReef*, a simulated coral reef experience accessed on Whyville.net. During the development phase of ConConn, the project team's intention was to leverage *WhyReef* in two ways. First, *WhyReef* was to serve as a platform through which core teen participants in Fiji and Chicago could develop a common knowledge and language base around the topic of coral reefs. Although *WhyReef* was successful in generating this common foundation from which both sets of teens could work, the virtual experience and accompanying graphics were too simplistic to engage core teen participants long-term. Second, *WhyReef* was intended to bring lurkers from *Whyville* to the social networking site built specifically for ConConn, where they would be asked to participate in both online and real-world activities. Despite the project team's best efforts, *WhyReef* was not successful in incentivizing a large number of lurkers to participate in ConConn activities.

### **Conservation Connection – Program Summary**

Conservation of coral reef ecosystems is most successful when action is both local and global. Using a combination of *WhyReef*, web-casting, blogging, vlogging, and a customized social networking site (FijiReef, <http://fijireef.ning.com>), ConConn attempted to engage American and Fijian teens as well as youth players on *Whyville* in the stewardship of reefs through direct involvement in the scientific process. This after-school program launched in January 2011 and concluded in June 2011.

*WhyReef* ([reef.whyville.net](http://reef.whyville.net)), a coral reef simulation and suite of learning-based gaming activities in the 2D virtual world of *Whyville*, was leveraged in order to ensure that core participating teens and *Whyville* youth gained equivalent knowledge in coral reef biology, ecology and conservation. They also took part in specific activities, such as Save the Reef, to gain insight into current reef conservation practices. Save the Reef recreated real-world perturbations, such as overfishing and bleaching, which caused the reef to slowly change in appearance and composition over a period of several weeks. Core teen participants and *Whyville* youth were asked to identify the cause of the catastrophe and help alter the state of the unhealthy reef. They used the Reef Simulator module available within *WhyReef*, which allows players to test their hypotheses about the reef perturbation and develop solutions that they can implement through civic action.

The FijiReef Ning was used by core teens, expert participants (e.g., marine biologists, conservationists, and underwater photographers), and *Whyville* youth to share and provide feedback on the ideas, blogs, photos, videos, and projects posted to the social networking site. Given that real-time collaboration was not possible between all participants (e.g. 17-hour time difference), the FijiReef Ning became the virtual hub where teens in both countries and *Whyville* youth created and shared blogs and videos to learn about each other and about topics in coral reef biology, ecology and conservation. These blogs and videos were then shared with peers and experts to communicate knowledge gained and to obtain valuable feedback to increase that knowledge. While core teens in different countries and *Whyville* youth did not work on identical projects, they were able to share ideas, critique each other's work, and learn from their peers and experts.

In this program, fusing virtual and real experiences was a powerful combination for learning science content and empowering youth to engage in science. By including real-world activities, core teen participants were able to connect knowledge gained in the virtual settings to the real world, gather data and information from their local communities to share with their international peers, and then use those data and experiences to inform their conservation plans. Each set of core participants went on four field trips in which they were able to engage with and learn about local aquatic environments and participate in hands-on science. Teens in Chicago, IL participated in a fish dissection, received a personalized tour of the Pacific coral reef exhibit at the Shedd Aquarium, performed DNA extractions on coral reef fish samples, and explored their local aquatic environment on a trip to the Indiana Dunes National Lake Shore. Teens in Suva, Fiji participated in a fish dissection, went on an investigative trip to a local fish market where they interviewed fishers about changes in marine resources, visited a nearby village in a locally managed marine area, and explored their local aquatic environment by taking a snorkel trip on a coral reef.

For their final projects, teens attempted to make a real-world impact on Fijian reef conservation efforts. Both groups decided that making educational/outreach pieces would be the most effective way for them to address specific threats to Fijian coral reefs and encourage locals in Fiji to take action. Teens in Fiji wrote an article, later published in the Fiji Times, to raise awareness of overfishing and outlined causes, effects and possible solutions. Teens in Chicago wrote an editorial for the Fiji Times that called attention to the problem of abandoned fishing vessels, and also produced a public service announcement on the effects of garbage on coral reefs (<http://www.vimeo.com/27538531>).

Through evaluation of the blog posts, videos and comments on the FijiReef Ning, post feedback surveys, and post program interviews we were able to assess the program learning, inquiry and attitudinal learning goals for the core teens. We found that through the multi-faceted digital and real-world activities of ConConn, core teen participants showed their understanding of the interconnectedness of life in a reef, how food webs are important gauges of energy flow, and the consequences of disrupting that energy flow. These teens were also able to comprehend the causes of degraded corals and the main threats to them, and showed a deep understanding of the importance of reefs not only for the health of the ocean but also for the health of all animals, including

humans. Core teens also obtained a solid grasp of the varying problems with implementing strategies to save reefs, from cultural roadblocks to economic ones. They were quite astute at seeing the problem from varying points of view and understanding who may resist such conservation plans. Final projects showed that core teen participants gained an understanding of the interactions within a reef ecosystem, how humans are impacting these interactions, and ways to solve these problems to keep the ecosystem healthy. Incorporating global perspectives on local issues allowed participating core teens to have a more holistic understanding of these issues.

### **Aspects of ConConn that Did Not Work**

While ConConn was educational for the core teen participants and achieved the learning goals outlined by program designers, some aspects of the program design did not work out as planned. Here, we highlight two ways in which the program failed to satisfy its core teen participants and failed to reach the broader youth audience from *Whyville.net*.

#### **Fail #1, The Simplicity of *WhyReef***

Core teen participants of ConConn used *WhyReef* as a primary source of information due to its content, ease of use, low barrier to participation, and ability to provide an immersive experience for youth players. Gameplay allowed teens to virtually experience the charismatic ecosystem that they were tasked to conserve. Despite *Whyville*'s median user age being around 12 years, within *WhyReef*, we had previously observed a large number of older teens participating, which surprised us initially when we launched *WhyReef* in 2009. We decided to leverage this teen interest and participation when designing the activities in ConConn. However, surveys and interviews of core ConConn participants revealed that playing in *WhyReef* had the least appeal for both Fijian and Chicago teens. From the feedback, we learned that the core teens felt that *WhyReef* was too simplistic for them. *WhyReef*'s appeal rated last out of the 10 program activities listed in the post-program survey. One Fijian teen commented, "(Honestly) I didn't really like playing on *WhyReef* because it was (no offense :) a bit childish but it was also very informative." During the first session of gameplay in *WhyReef*, both teens in Chicago and Fiji were highly engaged and excited to be using *WhyReef*. Over the next few weeks of the program, this excitement wore off as the teens determined that *WhyReef* was below their age level. While teens still gained valuable information and assets from *WhyReef* to use in program activities, as the program progressed, teens increasingly asked and turned towards more age-appropriate information sources (such as expert-created videos, museum specimens, and text books).

This attitude towards *WhyReef* was in stark contrast with another program run at FMNH, called the Kids Advisory Council (KAC). The KAC was comprised of 15 students, aged 10 to 14, and aimed to assess how youth use digital and real-world museum collections and how each of these formats may enhance the other. KAC participants used *WhyReef*, supplemented by hands-on experiences with coral reef specimens and collections, customized programs at a local aquarium, and real-world interactions with reef conservationists. Participants then demonstrated knowledge gained to an audience of experts and peers through video production. KAC participants were highly engaged with *WhyReef* and, during gameplay, simulated real-life scientific observations about coral reef ecosystems, mimicking the scientific process in order to inform solutions to real-world questions; and had real-life "scientific discovery" moments and opportunities for "higher-level" engagement (Aronowsky et al, 2011).

One key difference between ConConn and the KAC was the utilization of *WhyReef*. In the KAC, *WhyReef* was central to the program and a significant amount of time was spent playing in the virtual world. Surveys and interviews revealed that many of the KAC participants played in *Whyville* outside of program hours. In ConConn, the use of *WhyReef* was more of a springboard into the main goals for the program, and less time was spent there during the program sessions. Additionally, ConConn teens did not use *Whyville* outside of the program, as neither set of teens had sufficient Internet access outside of their schools. Thus, partly due to program design and access, ConConn teens did not become invested members of the *Whyville* community, and the games and activities were perceived as childish, stand-alone activities and not part of a vibrant virtual world. It is possible that if we had recruited core teens from *Whyville* into the ConConn program instead of partnering with specific schools, the use of *Whyville* may have been more robust and organic.

A second, and perhaps important, difference was the age of the participants in each program: 10-14 for the KAC and 13-18 for ConConn. *Whyville* is targeted towards ages 8-16, with the average player

age being 12.3 years (Kafai, 2010). Because the graphics and point-and-click mechanics of *Whyville* are geared towards an audience younger than the core ConConn participants, it may have been natural for them to feel that *WhyReef* was “beneath” them and not challenging. In the future, we plan to scale back the use of *WhyReef* in programming for teen audiences and instead use it as an introductory activity and as a source for information and digital assets.

A final difference was the length of the two programs. While each program used the same model of virtual, digital and hands-on activities, the KAC occurred over a much more condensed period of time (4 full-day and 2 half-day sessions run over the course of a month compared to the twice-a-week full-semester after-school program for ConConn). This time frame could have given the KAC program a feeling of immediacy for the KAC youth. In comparison, it is possible that ConConn, a semester-long program, lacked a sense of immediacy for teen participants. Additionally, the duration of ConConn meant that the program encountered competition with other after-school activities such as sports, drama, and social events.

### **Fail #2, Recruitment of Whyvillians**

A goal of the ConConn program was to create a community of interest-driven youth, generating and sharing content about conservation and coral reefs on the FijiReef Ning. Our plan was to recruit *Whyville* youth to the ConConn program to participate with the core teens from Chicago and Fiji and learn about Fijian reefs and their problems. To encourage the growth of this community, we placed an animated vertical banner in rotation on the main *Whyville* home page (to advertise the ConConn program throughout *Whyville*) and on the *WhyReef* Station landing page (to advertise to youth already interested *WhyReef*). This vertical banner linked to a ConConn landing page in *Whyville* that highlighted program activities, advertised virtual currency rewards for participation, and provided links to the FijiReef Ning. A “Y-Blast”, a message sent to all Whyvillians using *Whyville*’s internal e-mail system, was sent out near the start of the program. Finally, MarkEOL, the avatar for FMNH Curator of Fishes Dr. Mark Westneat and the acknowledged coral reef expert within *Whyville*, wrote an article for the *Whyville Times* entitled “Saving the Reefs in Whyville and Fiji.” This article was a call to participate in Save the Reef and to join ConConn to learn about and conserve reefs in Fiji.

Based on data provided by the parent company of *Whyville*, we know that 426,604 Whyvillians viewed the ConConn banner. Of these, 1,796 Whyvillians clicked on the banner to reach the ConConn landing page (a 0.42% click-through rate). Only 310 Whyvillians clicked through to the FijiReef social networking site (a 0.17% click- through rate), with 22 joining the FijiReef Ning. While these click-through rates are on par with click-through rates for similar sites (see below), we were disappointed with the low number of Whyvillians who joined the program and the even lower rate of participation despite the virtual currency incentives. Only six of 22 Whyvillians who joined FijiReef participated in the program and their participation was minimal. Most participation consisted of uploading a profile picture or commenting on content contributed by others. Only one Whyvillian contributed to an event by adding a blog about a coral reef species. Participation in *WhyReef* has been extremely high with 150,000 unique users visiting in the first year (Aronowsky et al, 2011), however, we wrongly assumed that this enthusiasm for *WhyReef* within *Whyville* would translate to enthusiasm for a related off-site program.

There are many reasons why participation among Whyvillians was low. The small number of Whyvillians who joined the program may have resulted from 1) the program existing on an external site and not embedded within *Whyville*; 2) only being able to see the front page of FijiReef and not being able to interact without creating a login; 3) requiring a new login and the completion of a short application form to gain access to the FijiReef site; and/or 4) a combination of any of these factors. While it is standard for many sites to require a login before posting comments and COPPA compliancy requires limiting access to member data before joining a site, it is possible that we would have had a higher level of *Whyville* participation if FijiReef had fewer barriers to membership.

However, another reason for the disappointingly low participation may have to do with our own expectations, rather than program design. It is possible that we set ourselves up to fail when it came to the participation of regular Whyvillians in ConConn. The ConConn click-through rate and *Whyville* participation numbers are lower than the accepted standard for Internet culture, the “90-9-1 rule” (Hill et al, 1992; Whittaker et al, 1998), that describes the percentage of people that will lurk (90%), comment on content created by others (9%), and become creators of content (1%). However, this “rule” might not be valid as online communities expand exponentially and become more specialized.

Some Internet authors note that a new rule may be emerging for different types of online interactions and for specific web niches (Steinberg, 2011). Data from Adweek suggests that there are significant differences in click-through rates for kid sites (0.37%), gaming sites (0.21%), and social media sites (0.08%) (Chapman, 2011). Given the Adweek data, we might expect *Whyville* click-through rates to be intermediate of these three values because *Whyville* crosses all three categories. Taking these newer opinions and data into consideration, our click-through rates are consistent for youth/game/social network click-through rates. Similar rates can be found anywhere on the Internet from Amazon.com to Wikipedia (Nielsen, 2006). We now believe that our expectations were skewed by the “90-9-1 rule” and not supported by more recent data and observations. We should have recognized this during the development phase of the program and planned accordingly.

Of the Whyvillians who did join the FijiReef Ning, low level of participation may be attributed to different factors, the first being the timing of the program. ConConn took place during the school year, a time when youth are typically at their busiest. We have found from four perturbations and Save the Reef events that we have facilitated in *WhyReef* since the 2009 launch that participation is significantly higher during the summer months than during the school year (Aronowsky et al, 2011, unpublished data). This also correlates with trends in *Whyville* where utilization peaks during school holidays. In fact one 11-year-old Whyvillian who joined the FijiReef Ning noted in a comment “yea me (sic) and my family are always soooooooooo busy now in days.” A second factor that may have impacted ConConn participation by Whyvillians is the fact that ConConn activities included a significant amount of video production. While many youth have access to some type of digital camera, this does not mean that they are allowed to use the camera, or have the ability to create a video about an academic topic. For example, when a facilitator asked one *Whyville* member of the FijiReef Ning to contribute a video, she replied, “I don’t think my mom would let me post videos and I would need her help...so...” A third factor that may have deterred participation by Whyvillians was a perception that the program was exclusive to the core teens in Chicago and Fiji and not open enough to the needs of Whyville lurkers. As the program progressed and more content was contributed and discussed via the FijiReef Ning, the content and comments morphed into a discussion of and by the core participants. This may have made lurkers feel like outsiders instead of invited guests.

This lower than expected rate of participation from the Whyvillians had a negative effect on the program learning and attitudinal goals, as we were not able to engage a large number of youth to learn and participate in Fijian coral reef biology, ecology and conservation. Only a small number of youth outside of the core teens were exposed to Fijian reefs and the global problems that they face. We are unable to assess if this low-rate of Whyvillian participation had any effect on the core teens. As stated above, we found that the core-teen received a rich experience from participation in the program. We can only speculate that an increased participation from *Whyville*, and hence disseminating to a broader audience, could have had an additional positive effect on the core teens.

## Conclusion

From ConConn, we found that involving youth in ecosystem conservation is most successful when virtual, digital and real-world activities are fused to allow youth in disparate locations to enter into active, social, and meaningful relationships with each other, science mentors, and their environment. However we must pay close attention to the types of virtual worlds and digital media used to engage those youth. We should not assume that successful implementation of a virtual world in one program is transferable to other programs with different goals and demographics. As recent data and opinions suggest, digital participation rates may be decreasing and evolving and our future program designs will consider these facts more carefully. Running a program that is both tailored for a core group of teens and lurkers is a delicate balancing act, and one that requires more thought on the part of the project team prior to re-implementing this program model.

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# The Canary's Not Dead, It's Just Resting: The Productive Failure of a Science-Based Augmented-Reality Game

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**Abstract:** A prototype alternate-reality game called *Canaries in a Coalmine* presented players with an ominous message from the future, a modern-day battle with overly sensationalized media, and a challenge to both solve the game's mystery and take environmental action in the present. Designed to engage a broad public in citizen science using high quality scientific digital resources to build knowledge about complex scientific issues facing our society, *Canaries* failed...or did it? Fewer than expected players interacted with the game, prompting the designers to close the game without it being played through to completion. The designers and researchers share lessons from this experience that can inform the education and gaming communities.

## Introduction

The Educational Gaming Environments group (EdGE) at TERC designs free-choice games that engage the public in scientific inquiry. The participatory framework that we use builds upon the growing understanding that the Internet and social gaming are revolutionizing the way educators think about learning (Collins & Halverson, 2009; Falk & Dierking, 2010). To investigate how digital scientific resources can be infused into social games, we created and studied a prototype Web and Flash-based alternate-reality game (ARG) called *Canaries in a Coalmine*. In this paper, we present the lessons learned in the less than successful implementation of the game. Some of the difficulties may stem from the challenge of embedding citizen science into any form of game and others may come from the designers' assumption that a social community could form more easily than it did.

## The Vision for *Canaries in a Coalmine*

The goal of *Canaries* was to introduce and engage the public in citizen science, using high-quality scientific digital resources to support players in understanding complex scientific issues facing our society. This work builds on literature that shows that 1) games can be richly complex and engaging learning environments (Gee, 2003; Barab et al., 2007) and 2) successful game play can foster collaborative problem-solving (Steinkuehler & Chmiel, 2006), systemic thinking (Squire, 2003), and can increase players' collaboration and civic activity in real life (Barab et al., 2005; Ito et al., 2008; Lenhart et al., 2008).

We chose an alternate reality format for the game in the spirit of games like *World Without Oil*. We felt that an alternate reality approach would engage players' imaginations and interest by allowing for a storyline driven by the players' actions. This also provided the designers with great flexibility for crafting the story around science content that could be woven into challenges. *World Without Oil* engaged over 1,800 people to live out a fictional oil crisis online for a month (McGonigal, 2011). We were attracted to the game's method of combining an online fictional narrative with real-world activity and documentation. While we were designing *Canaries*, McGonigal's team released another game, *Evoke*, which reinforced some of our design considerations. *Evoke* was more "text-heavy" in nature and it was felt that *Canaries* should strive for a more graphic and activity-based style of delivery and narrative.

As conceived, *Canaries* was to engage players in real-world activities in their own neighborhoods. These activities would include observing birds in their habitats, considering threats to birds in the context of local and global ecosystems, and taking environmental actions when warranted. The activities would be driven by an unfolding storyline about a mysterious message from the future that birds are key environmental indicators that had been ignored in the past and a journalist's vicious battle with a tabloid newspaper that ensued over the validity of the message:

Jade Moneitree, a former journalist and recent recipient of a large cash settlement from a legal dispute with the Daily Rap tabloid, has created a foundation to re-instate evidence-

based reasoning in a population gone wild with sensationalized media and has invited volunteers to join her. Their first task: to work together to solve the mystery of an ominous video message and clear the reputation of Frank Martine, a scientist and friend of Jade's who is being besmirched by the tabloid. Within the message is the idea that "birds are the key," which is meant to justify the challenges presented in the game to learn about birds and their role in Earth's future survival.

Presented with the beginning elements of the story and invited to "heed the call," players would join the foundation and be given an office with tools and resources related to birds. The office (Figure 1) included communication tools and a series of challenges that ask the community to unpack a bunch of tabloid stories, provide evidence for what is science versus pseudo-science, and otherwise tackle the mystery and the science of what was happening. To do this, they are encouraged to become involved in associated real-world activities and return to the game to document their activities and findings.



**Figure 1: The office in the first launch version of *Canaries***

## The Design

When designing *Canaries in a Coalmine*, our team had to find a balance between a storyline nimble enough to be adjusted based on community input, and real-world science resources and activities well-integrated enough to support deep understanding of stewardship of the natural environment. Since this research project was funded to target how to distribute digital scientific resources through games, the designers focused on creating challenges that would encourage players to share resources such as bird-call libraries, citizen science resources, and activist sites. A rating system allowed players to acknowledge the value of resources other players posted and resources were listed in order of highest rating. These features were put in place with the intent to create a community of scientific inquiry among the players, incorporating their real-world activity and fictional online narrative.

A set of casual mini-games (Figure 2) introduced methods to identify birds through images, silhouettes, and calls. To encourage players to return, new mini-games were revealed daily. Although players could guess in the mini-games, the point structure rewarded getting it right on the first try and therefore, finding and using Web-based resources. Players were also given a life list tool for documenting personal bird observations, which overlaid their sightings onto a Google map.



**Figure 2: Two sample mini-games**

Players were awarded badges for completing challenges (Figure 3) and other activities in each of three categories: *awareness*, *knowledge*, and *stewardship*. Players were expected to post information and data from their responses to the challenges and their contributions would be rated by other players voting with a “thumbs-up” or “thumbs-down”—earning them more points for higher ratings. In addition to being a form of peer-reviewed resources, the voting structure allowed players to become recognized as leaders in the community.



**Figure 3: Two sample challenges**

## Launch

*Canaries in a Coalmine* was first available to the general public (ages 15+) for eight weeks starting in August 2011. Then it was taken down, redesigned, and re-launched.

### Initial Launch

For the initial launch, at least one team member monitored the game most hours from 8 am to 8 pm EST. During these hours, about 10 people arrived each hour. We used a commercial monitoring tool to help us track visitors, which enabled us to identify when players entered the site and whether they registered. Once players registered, our game-tracking software identified when they played mini-games, did challenges, and posted to forums. In addition, an embedded chat feature let team members who were playing roles within the game talk with players.

*Canaries* failed at gaining an initial audience. The home page had 2,000–3,000 visits, which translated into about 75 new registrants. Fewer people participated than we had hoped, and of those who came, few went beyond the registration page. Approximately 20 people posted game activities and only 10 players engaged in chat sessions.

### Second Launch

Towards the end of the first month, fewer new players started the game and players that had been engaged began to drift away. We decided that the game needed to be revised to have any chance of garnering a community. We suspended the game while the designers regrouped to identify changes that might increase registration and engagement. Operating under tight time and financial constraints,

we knew our options were limited and changes had to be tactical. The primary focus of the revisions was to create a more engaging introduction and facilitate more interactions among the players.

**New introduction.** The designers saw that too little information was provided at each step about why a player might want to continue. We created a more in-depth, dynamic introduction to explain the story (Figure 4) and moved the registration page to the first point at which a player tried to enter data. We also implemented an entry point to let potential players try the mini-games and poke around the site before being asked to commit to registration.



**Figure 4: Expanded introduction**

**Office Reorganization.** The designers reorganized the “office” dashboard to highlight communication and collaboration (Figure 5). We made chat and activity log windows open upon entering the game, allowing players to immediately see one another. When players closed the chat window, an icon showed when others entered the chat. Players could now be in any part of the game without missing an opportunity to connect with others. Player profiles were enhanced so that players could learn more about the current activities of others in the game. Finally, to provide a clearer path for players toward the activities that would increase community, we reorganized the challenges into themes and created mouse-over tool tips that showed players what each office element did.



**Figure 5: Revised office with news window open**

### Recruitment approach and issues

*Canaries'* primary barrier to success was in being unable to recruit and establish a community. The reliance on that community so early in the gameplay meant that nothing meaningful could happen without a critical mass.

Our recruitment was substantial, given our budget, but still insufficient. About \$10,000 (about 10% of the overall development budget for the game) was allotted for advertising and recruitment. In the end, only about half was spent because much of the paid advertising was not generating sufficient traffic.

Our efforts included advertisements, press releases, and secret game clues that were distributed in a variety of ways to gaming enthusiasts, informal science centers, citizen science groups, naturalists, educators, and others. For both game releases, we advertised. For the first release, we advertised on Mochimedia and Facebook, and posted a press release on gamedev.net that was forwarded to game development blogs and email lists.

Our outreach team searched for blogs and email lists of potential players, and posted to many of them, but some were private and discouraged posts. The advertising brought players, but not necessarily interested players.

We distributed fifty flash drives with the URL, a game clue embedded in a birdcall, and sound analysis software to help find the clue. The URL led to a fictitious hacker page that had information about Jade Moneitree's organization, which was intended to offer other clues to help drive the game in a more subversive manner. There was no evidence that any of the flash drives resulted in players entering the game.

For the second release, we e-mailed the 100 or so previously registered players, putting a sample mini-game on Mochimedia, posting press releases, blog posts, and on relevant web sites, and recruiting by large email lists for science educators, birders, and gamers. We did not re-instate paid advertising.

Even with the enhanced second release, a sustainable community did not form. Players came and individually interacted, but players were rarely there simultaneously. In addition, there was still not enough back and forth between participants to create a community of inquiry. Although we did have a small group of interacting players who wanted *Canaries* to continue, the limited audience did not merit the time it would take for us to facilitate the game and create new materials. With regret, but knowing we were making the right decision, we closed *Canaries*.

## **Lessons Learned**

With hindsight, we still think many of our game elements are strong (which makes the failure to catch on all the more disappointing). The scientific resources were high quality and well integrated into the game. The mini-games and challenges were fun. The storyline was engaging. Visually the game was appealing. Regardless, an ARG is not much of a game without players.

The game itself was not without problems, however. Because of budget limitations, we focused development efforts on tools for embedding and rating scientific resources in the game environment. This meant that other elements of the game were possibly insufficient to have wide, long-lasting appeal. Some tools were simplified more than ideal, such as the life list tool. Others were cost-prohibitive to build, such as an integrated discussion and activity feed where people could work cooperatively toward consensus. Instead we relied only on a third-party forum infrastructure for consensus building. Finally, we lacked the resources to polish the design or do as much quality-assurance testing as we would like.

### **Sigh, have a bigger budget**

One interpretation of our experience is that one needs a bigger marketing budget to get the word out. We have received additional funding for our next round of development and have a larger budget, which will allow us to do a bigger blitz the next time. In particular, we will work with members of our target audience to test and better hone components and to foment buzz in the process as well as build on the marketing outlets we identified for *Canaries*.

But we also learned another lesson that is potentially more important than increasing the budget.

### **Promote our work as a part of practice**

Through *Canaries*, we really learned that part of the regular work process has to be promoting our work. We need to have an online presence representing our work and we need to connect with other gaming researchers, educators, designers, and players. Then when we want to get beta-testers or announce the release of the next game, we can tap into a larger, built-in audience that is familiar with our work, and we will know how to target our marketing resources more effectively.

Our efforts are multifold. We are redesigning our web site to be more appealing and easier to update. We are using social media tools that allow our outreach, design, and research teams to coordinate postings to our blog, Twitter, and Facebook. We previously read and discussed articles and played and discussed games internally, but now are beginning to post the results of these discussions publically. We also are paying more attention to what others are saying on social media. We are working with teachers to make them aware of our work. Moreover, we are going to more conferences and trying to meet more people.

### **Know your audience and reach out to them**

We learned the value of teasers and pre-registration samples to entice players before asking them to register. This may mean that researchers lose a bit of early data, but in the end, they may keep more players. Developing an ARG like *Canaries* is a time- and cost-intensive endeavor, and sacrifices along the way due to constraints of either are magnified and hard to recover. As such, EdGE has changed tactics somewhat in reaction to *Canaries* in that we are building a set of smaller, mobile games that we can do less expensively, more nimbly, and market to a wider audience.

### **Emphasize social presence in the game**

Our previous experience with social presence among players that occurs in a massively multiplayer online environment (MMO) did not translate immediately to a non-avatar environment. Our previous science inquiry game in an MMO used a similar mystery narrative and facilitation style (Asbell-Clarke et al., 2011; Asbell-Clarke & Sylvan 2012). This game was an activity within an existing environment, so the community came to the game rather than the game having to recruit a community. This may have been more important to the growth of the community than we realized previously. *Canaries*, which did not have avatars, showed less interactivity among players and players did not come to synchronous events, despite posted notices.

For both the designers and the players, creating a social presence or community—even among the small number of players—was difficult. We may have assumed too much of the avatar-based social presence that occurred in our previous MMO work (Asbell-Clarke et al., 2011) would carry over to the Flash-based web game, and they are just not comparable. In *Canaries*, people completed the challenges and posted comments, but our initial design did not support players responding to one another's activities. They could enter the chat room to talk with our team members' characters, but if we were not sitting in chat at that split second, players would leave immediately. Before the revisions, members had to rely on seeing players' avatars in chat to 1) know that others were in the game at the same time and 2) provide an impetus to start a conversation. We assumed that the chat and forums would be vehicles for communication and inquiry among players, but that was not the case, even with the modifications to the game.

### **The narrative grows with the community**

The narrative was designed to be flexible enough to grow and reflect the community's input. Some players were quite engaged, which supported the designed narrative arc. However, keeping these players engaged, pushing the narrative forward, and growing the community all at the same time was difficult.

A better strategy may have been to create short narrative elements that were less dependent on community input, allowing us to reach a critical mass that could engage in a more complex and fluid storyline. Having these simpler elements may not have led to a larger community, but perhaps the community would have grown fast enough to push the game forward and to complete the game.

### **Doing it differently next time**

Some of the most enthusiastic players were teachers who saw the potential for *Canaries* in a more structured setting (such as a class project or in an after school program). We are currently using *Canaries* in a few small, informal settings such as local science festivals, where our designers are soliciting ideas from educators and the public about how they might engage with the *Canaries* environment. We have also attended science teacher conferences and other events and have been

connecting with teachers both locally and nationally to relaunch *Canaries* as an in-class experience. Teachers as facilitators will help drive the game, especially as much of the game's elements are aligned to meet science standards, but are delivered in a format that will interest students tired of more traditional methods of learning.

We are re-thinking how to approach social interactions in games. We realize that the social element, while essential to the scientific inquiry, may not be the best place to start in a game. Perhaps it is better to start with rich activities and then build social elements around them. We are doing this to establish some visibility as game designers before trying to recruit a community from scratch for an inquiry game again. The alternate reality genre is not often listed as one of the categories used on game publicity sites (e.g., Mochimedia). We are developing our new games to fit into one of the common categories such as action or puzzle, at least until we have a public following.

It could be that gamers who might be attracted to an alternate reality game format are not so interested in citizen science and birds. We will not know that until we figure out how to find the proper recruitment methods for a game like *Canaries*.

## Conclusions

*Canaries in a Coalmine* was intended to engage public gaming audiences in an alternate reality game that enticed them to participate in citizen science in their own backyard. Because of budget constraints, we had to make difficult design choices and limit our advertising. These limitations along with inadequate social presence and narrative elements reduced the game's appeal and, thus, the player community.

We learned some important lessons along the way. Small groups like ours may benefit from building their audience throughout the design and development process, regardless of how pressing deadlines feel. The ease with which particularly gaming environments support social presence is an important consideration, particularly for alternative reality games. Growing the community takes time and effort and players need to be kept engaged while the community grows. One way to do this is to create many short and flexible narrative elements can be used flexibly.

Going forward, our next games are being designed and developed with these lessons in mind. And *Canaries*, while resting, is returning as a classroom activity supported by teachers.

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# **Papers**



# In Torpor, Not Dead: A Look at a Collectible Card Game That Sticks Around

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**Abstract:** *Vampire: The Eternal Struggle* (VTES) is a multiplayer Collectible Card Game (CCG). Being one of the first CCGs released in the mid-1990s, VTES has survived going out of print twice. An active community still plays and supports the game. This paper examines the history, the community, and the factors that may have kept the game strong over eighteen years. The paper also aims to capture players' reactions to the game going out of print and publisher stopping support for the second time. Quantitative and qualitative data was collected from multiple resources: online survey, interviews, and observations. Preliminary analysis revealed that the community involvement is multilayered and encouraged by the game mechanics. While complex multiplayer game mechanics require interaction among players and foster community creation, it also intimidates new players joining the community. After examining the preliminary results, we will briefly discuss implications for community building.

## Introduction

Rapid development of information communication technologies has increased interest to study online gaming communities. While communities emerging around digital games, especially Massively Multiplayer Online Games (MMOs) have been of interest to many scholars (Koivisto, 2007; Taylor, 2006), fewer researchers have attempted to examine communities of non-digital games. We are interested in investigating the communities that form around Trading, or Collectible Card Games (CCG). In particular, we will be looking at a multiplayer CCG, *Vampire: The Eternal Struggle* (VTES), which requires more than two players.

CCGs are card games for two or more players. Their distinguishing features are the aspect of collection, where a player will acquire cards for their collection, and player design, as the player chooses which cards from their collection they will use to make a particular deck to play with. This fact that each player plays from a different set of cards is part of what sets them apart from other games. Although CCG cards are premade, players design their own decks from the cards they own by choosing which of the cards they will use for a particular game. This, in turn, can imbue a sense of ownership to the card deck and the game.

We are not going to explain in detail the history of CCGs or what they are. For more explanation on the background of CCGs, please see a previous paper (Adinolf & Turkay, 2011). That paper investigated motivational aspects of CCGs with a close examination of VTES. In that paper, authors identified three aspects of CCGs that attract and engage players: collection of cards of varying rarity, creating decks from the cards players have collected, and engaging in community activities with other people who also play the game. Among the three, the community aspect of VTES seems to be the most fun and motivating for players. More than 75% of players in the study had indicated that they like the community aspect of the game to a moderate to large extent (Turkay, Adinolf, & Tirthali, 2012). In their empirical study with *World of Warcraft*, Mysirlaki & Paraskeva (2010) had found a similar relationship between communities and motivation to play the game. They concluded that the development of communities in a game may increase intrinsic motivation to players and enhance their performance in the game.

The relationship between multiplayer games and the communities they spawn is firmly a two way street. A multiplayer game that fails to create a solid community of players will likely fail itself. This is truer for non-digital games, as players need to meet face to face to play. Unlike online games, which can match players from disparate areas, non-digital game players will have a hard time finding other people to play with, if no community forms around a game. In the case of CCGs, the game publishers usually foster this community, as their business model is based around a returning player base, buying expansion packs.

What happens, then, when a CCG goes out of print? In many cases, the community fades quickly. After all, without outside organization, and without the motivation provided by new, exciting cards, entropy will take over, and the community, as well as interest in the game, will dissolve. We will take a particular CCG community, the VTES community, as a special example while mentioning other CCGs in comparison. This line of research with CCGs is driven by their potential as the point of interest which brings people together, and the role of player involvement in games' life cycles. Therefore, our research questions are:

- What aspects of VTES have led players to actively try to keep a game alive after it is no longer in publication?
- What are the different levels of community involvement in the survival of VTES?
- What are players' reactions to discontinuation of production and support from the game company?

## Background

The majority of existing studies on CCGs examine the social aspects of these games (e.g., Lenarcic, J & Mackay-Scollay, 2005), but does not look in depth at their power of community creation. This may be true because of several factors. CCG communities may not fit into either of the most commonly researched categories: location based communities and online communities. The communities that evolve around CCGs are a sort of hybrid, consisting of a large number of small, location based communities of interest, spread across the world. Each local playgroup might seem quite small, but via online forums, Facebook groups, and larger events where players come from around the world, the aggregate is a far larger community structure. This makes it difficult to fit into one category. In a similar vein, Kinkade & Katovich (2009)'s ethnographic study describes existence of *Magic the Gathering* (MTG) community in local Texas and makes a note that websites, such as forums, are the places where MTG players foster the sense of community. Below is their description of MTG players connecting online and offline (Kinkade & Katovich, 2009, p.22):

As people become connected more ethereally to each other, and as their sense of community becomes less linked to conventional time and space anchors, becoming a regular seems more detached from the markers that other ethnographers, in established places open at discrete times, observed. The idea of anonymous regularity, more applicable it would seem to web sites, becomes more apparent in face-to-face encounters such as MTG. What we observed in MTG seems as an extension of a transition observed in web sites in which commonly accepted definitions of time and space give way to more ethereal versions as new communities form.

Acknowledging the methodological and practical difficulties of studying communities that exist both online and offline, in this study we will aim to investigate the VTES community that has supported the game over 17 years, even when the game company stopped publishing and supporting the game, and characteristics of VTES that create and nourish the existence of this community. The following section is a description of VTES and its design characteristics that distinguish it from other CCGs.

## What is Vampire the Eternal Struggle (VTES)?

In 1994, following on the heels of his massively successful *Magic: The Gathering* (MTG), Richard Garfield revealed VTES, originally titled *Jihad to the World* (Extrala). Having learned from watching people playing MTG, Garfield designed VTES to be a more socially dynamic game ([vtesinla.org](http://vtesinla.org)). In a nutshell, VTES is a multiplayer game, with every player acting for themselves. Unlike many multiplayer games though, each player only has one player who they directly want to attack—their *prey*. Likewise, there is only one person who directly benefits if a player is *ousted* from the game, that player's *predator*. This predator-prey system creates the opportunity for temporary alliances among players who are not yet in direct conflict. They may agree to act in accord out of mutual self-interest. Thus, unlike two player, or multi-player free for all games, VTES has a built in structure encouraging discussion and deal making. While the players may be enemies during play, they may be friends, mentors, or collaborators in the broader context of the play community.

In 1998, after 2 years of no new publications, the publisher, Wizards of the Coast, announced that they would be halting production of VTES. The game remained out of print for 2 years, until 2000, when White Wolf picked up the game. Right out of the gate, the returning expansion, Sabbat War, sold out. For the next 10 years, the game continued publication until September 2010, when White Wolf announced they would cease printing and supporting the game once again. As of January 2012, the game company does not own any VTES cards.

In order to keep the game fresh, the two successive companies that owned the game published 20 expansions over thirteen years. These expansions had varying numbers of new cards and new rules. As these expansions were released, VTES followed a different design and play strategy than MTG. Namely, the designers of VTES went to great lengths to ensure that as many cards as possible remained playable. Indeed, there are, at the time of this writing, only 11 cards ever banned from tournament play. MTG, on the other hand, has a far larger banned list, and indeed the most popular format, known as “Type 2”, allows only the 2 most recent blocks of expansions. These philosophies each aim for the same thing: to allow players to be as equal as possible in a tournament setting, even if they haven’t been collecting cards for very long. *Vampire* does it by trying to keep the power level even over time, while MTG does it by essentially completely resetting every two sets. As a player, the first author finds the MTG strategy to be unappealing and overly commercial, but perhaps that partly explains its far greater financial success.

In summary, distinguishing aspects that might be supporting community of VTES are its multiplayer aspect, complex gameplay and relatively inexpensive card collection.

### **Communities and Games**

When we talk about emergent communities in games, we are mainly referring to choice based communities or communities of interest, centered on playing a particular game, rather than location based communities. Community members meet, either physically or virtually, to play, discuss and socialize. There may be several layers of such communities, with varying degrees of connectivity.

Communities in online games, such as MMOs, almost always form thanks to their built-in easily accessible communication channels and thanks to the gameplay itself (Koivisto, 2007). Game mechanics and the game world can support and mediate the community. These communities are also supported outside of the game through forums, fan fictions, and/or gaming conventions.

Although they may not be as large as online game communities, communities that form around a single card game can also be very strong (Yu, 2007). Every participant contributes to the community at some level. For example, in the case of VTES, a player might be involved with their local play group, but that group might be a part of the larger regional, national, or international VTES culture. Participation in the community might be as little as coming out occasionally to play a game or as involved as participating in in-depth discussions of rules and strategies both online and offline, traveling long distances to participate in major tournaments, and even designing cards for expansions.

These gaming groups “create cultural systems” (Fine, 1983, p.2). Through player interaction and participation, these shared cultures can become extensive and meaningful for player groups (Fine, 1983). Kinkade & Katovich (2009) state that becoming a participant in the community and contributing to the dynamics of the game are more important for MTG players than the competitive game-play itself. At many occasions, player communities decide whether they will let a game die or make it survive, especially after the game company no longer supports the game.

Although many games have been discontinued, there is a lack of literature about what happens to the game and the game community after the publisher stops supporting a game. A few studies have examined the closure and after closure of MMOs (e.g., Papargyris & Polumenaku, 2009; Peace, 2009; Consalvo & Begy, 2011). However in the case of CCGs, the literature is close to nonexistent.

There are differences between what happens when an online game shuts down and when a CCG is no longer supported by the game company. Players of online games may be able to keep the game alive through creating fan fiction and memorial websites for their game (Consalvo and Begy, 2011; Pearce, 2009). For example, Consalvo and Begy (2011) describe how Faunasphere players created a Facebook group and an online forum to share their experiences from the game through fan fictions and stories after it shut down. Papargyris & Polumenaku (2009)’s study documented player attempts to negotiate with game creators and community’s move to another game after Earth & Beyond shut down. While the shutdown of an online game may mean that players lose their game, this is not the case for CCGs. Although there may not be any more new cards published by the game company, the player community can continue to use existing cards, and may design new cards and modify the game rules.

As documented, fans contribute significantly to CCG's existence similar to online gaming communities. Bisz (2009) talks about *Middle Earth CCG* (MECCG), a CCG based on J. R. R. Tolkein's Middle-Earth. Players make efforts of the to keep the game alive in any way they can, such as creating game art and organizing tournaments, and participating in discussion forums after it went out of print in 1999. He elaborates on how after the game was out of print, MECCG players chose to change the game goal from winning to just experiencing the relaxed and fun game with friends.

Similarly, while VTES publisher, White Wolf, has stopped printing the game, and no longer supports it, players have stepped up, for a second time, to support the game. VEKN, the player run organization that organized tournaments during the first hiatus from 1996 to 2000, has stepped back into the role. During the first period of inactivity of VTES, local playgroups sometimes designed their own cards for use to keep the game interesting (see Figure 1 for an example). This time around, the *international* community is already creating new cards for play and online publication. VEKN maintains current rules for both casual and tournament games. They also adjudicate disputes over card rules and interactions. As of today, VEKN has 1083 members registered on their site. Thus the community is taking steps to ensure its survival on many fronts, which we will examine later in this paper.

After presenting our data collection methods, we will discuss what we found about player attitudes about the community, closure of the game, and their plans about the future of the game.



**Figure 1:** On the left is a custom made card. On the right is an original VTES card.

## Participants and Design

We used online surveys, interviews, and observational data to develop an understanding of why and how the VTES community keeps the game alive and how VTES players felt about the closure of the game for the second time.

An online survey was used to collect quantitative and qualitative data through snowball sampling on public and private VTES forums and players' personal blogs. A total of 365 players ranging in age from 18 to 59 ( $M = 32.17$ ,  $SD = 6.4$ ) filled out the survey. On average participants have been playing VTES 9.82 years ( $SD = 4.95$ ). 57.7 % of them were from European countries and 35.3% were from North America (USA and Canada). Players from 39 countries filled out the survey. In addition to the demographic data, we collected data on participants' play habits (e.g. how do you construct decks?) with five multiple-choice, three 7-point Likert scale and seven open ended questions. In addition, we conducted semi-structured interviews with seven VTES players during a tournament in North East United States. We asked six questions about their involvement in the VTES community and the role of the community in their motivation to play the game (e.g. What do you enjoy about the VTES community? How has your role changed since White Wolf announced that they will stop publishing and supporting the game?). We also conducted analysis of the forum postings to understand player reactions to the announcement right after the game company announced that they will cease publishing and supporting the game. Data included 105 individual posts from 70 players in two VTES forums. Data was analyzed using the quantitative data analysis software SPSS 18.0 and qualitative data analysis software Nvivo 9.0 by using inductive codes. The next section presents preliminary findings on the research questions.

## **Findings**

### ***Where is the VTES community?***

Players come together to play VTES once or twice in a week either in a game shop or in one of the player's houses. They prefer local gaming shops because there is a built in community with mentors and a competitive atmosphere. For example, New York players worry about nonexistence of a game shop in Manhattan, NY, where they can both play and introduce the game to other players.

Another place where VTES players can meet is VTES online or JOL (jol.net). It is a text based environment and requires players to type commands in order to play. We are not going to go in detail about differences between the online and offline game, as it is a topic for another discussion. Similar to the previous findings on online versions of CCGs (Bisz, 2009, Trammer, 2010), players do not find online play as satisfying as face-to-face play. However, many use JOL to try out new ideas and challenge themselves against interesting deck designs. Also, players use online forums or a Facebook group to just stay in touch with other players.

### ***What did players say about the VTES community?***

In the online survey, 76% of participants stated that they are motivated to play VTES mostly because of the community, and 14% of participants mentioned community as one of the main differences of VTES from other CCGs they have played. The following is a representative quote from a Hungarian player "First of all the players. We have a good community. Also this game forces you to think and it has great and exciting game method and clear rules." [SP\*44] Similar to MTG players in Trammell's (2010) study, many VTES players also consider the game as a hobby and a reason to get together with friends they like. Exchanging ideas is one of the functions of the community. This fosters generation of interesting concepts for decks. One player stated that he liked that VTES players are very open to give good ideas for his deck even if they may play against the deck in the tournament.

All the players we interviewed indicated that the VTES community is a major motivation for them to play. One of the players mentioned the VTES community being similar to a club one belongs to and enjoys the club activity: playing VTES. One player also admitted that the importance of the community for him has increased over time for the last five years. Two of the interviewees emphasized the common likings in other types of games among the VTES community members they have met. This opens another opportunity to "hang out" with players they like. As an Italian player states "I like the game mechanics, but mostly what makes VTES a good game for me is the community and the possibility of meeting interesting people to play with all around the world." [SP79]

Players enjoy the VTES community for several reasons. Among those are friendliness and a common interest in playing similar games other than VTES. Both in the survey and in the interviews, players mentioned that in general, VTES players are very hospitable, mature, and gracious. It seems to be a common practice to find other VTES players when travelling to other cities. They also like the sense of common purpose or interest they share with people around the world.

When we asked whether game mechanics have any effect on the community building aspect of VTES, all the interviewees answered yes. They mentioned the multiplayer aspect of VTES which encourages and requires interacting with other players not only in a competitive but also, many times, in a cooperative manner (cross table ally mechanic). Relatively long game sessions were also given as an example of mechanics that allow people to talk during the game play. For example, a VTES game session can go up to 2 hours, and tournaments can take up to 8 hours. In these sessions, the amount of thinking, strategizing, making deals and trying to win while every other player is trying the same, creates a unique social gameplay experience. Oftentimes, players carry metacognitive discussions about their game play outside of the game. They discuss their achievements, mistakes and possible changes that need to be made to their decks. These discussions take place face to face as well as online. All of these may help players to get to know each other quicker and forge friendships.

### ***How did players react to the news of discontinuation of company support?***

Players received the announcement of discontinuation on multiple online VTES forums on September 2010. In two of the popular VTES forums, players reacted to the announcement in various ways. There were 105 forum posts from 70 players as a reply to the announcement. Over 25% of players expressed their sadness, disappointment and somewhat frustration because there would be neither new cards nor reprints produced by the company. Along with the sadness, many followed with thanks

to certain people involved in keeping VTES running over ten years. A majority of postings, 76, showed hope for the future of the game and determination to play VTES and organize local tournaments for the game they love. They not only came up with ideas to keep the game alive but also showed examples of CCGs that went out of print but still have active player communities, such as MECCG or Star Trek CCG. Along with hope, players also admit that without new cards being published, it would be difficult for the community to get larger as the new players have to depend on the old players. Others, 13 players, showed indifference or resignation towards the news while 17 showed confusion regarding the reasons of the game company's decision to cease production, and some players felt misguided with respect to the reasons. Many players commented on the closure with humor by using cards or rules from VTES, as the theme has much to do vampires and death. Torpor is a term used in VTES when a character becomes incapable of acting until rescued by spending resources. Following is one player expressing his hope: "I really hope the game will continue, and maybe one day someone will have the 2 points of blood needed to do the 'rescue torpor action'" [FP65]

Among the players we interviewed, discontinuation affected different players in different ways. While some became more active, others did not change at all. For example, one of the participants started a blog to document his creative ideas about deck building and keep the interest in VTES by inviting other players to comment on his ideas, and to publicize the results of the local league he initiated to encourage competitive gameplay.

### ***What are the different levels of involvement of the VTES community?***

There are various levels of player involvement in the community. Being an active player is the most basic, and important one. Two of the interviewees described themselves as players who will play at tournaments because they do not have enough people in their town to play the game regularly. So, they travel to big events to meet with the community members and play the game.

Players produce a knowledge base through wikis and blogs about the game similar to players of popular digital games. Many player blogs contribute to distributing knowledge about VTES, brainstorm deck design ideas, and inform others about tournaments. There are many fan created instructional videos and recordings of VTES games on YouTube as well as other forms of fan fiction such as rap songs written by using the VTES card texts or videos of scripted plays with game characters.

Higher-level involvement in the community includes being a "prince" of a city, which usually requires organizing tournaments and encouraging new players to join the game community. Furthermore, some players take the role of a national coordinator and fan designed cards such as one of our interviewees. He summarizes his role as "...I try to be a player as everybody else while at the same time I am also currently national coordinator for US. So, I help with tournament coordination...I am a liaison with the global players network... as far as I say people are generous and gracious, I try to do the same. I invite people and glad to show them around the town when they visit. I am often a source of wisdom of deck building strategies, people often come to me for that...since the CCP stopped the game, I am the design team leader for the upcoming fan set.. my role has changed from perpetuating the game through participation to perpetuating the game through content creation" [IP4]

## **Discussion and Conclusion**

What aspects of a CCG will lead players to actively try to keep a game alive after it is no longer in publication? Do games with better social mechanics promote a stronger sense of community and camaraderie? Do strategically deep games do the same? We can't answer these questions in a general sense. Our data comes from only one CCG. Nor is it feasible for us to expand our study to the breadth such a survey of the industry would require. After all, we would have to: identify multiple games in both categories, both player supported and not; find players that currently play the former, and, more difficult, those who had played the latter. This means that, to be statistically meaningful, such a study would involve tracking down hundreds of players individually and then trying to administer a questionnaire or interview.

At this time a study of such scope is beyond our means to conduct. What we tried to provide is a snapshot of one community that has been established over 18 years of game's life and echo players' reactions to the closure of VTES. This paper presents initial findings from the data collected so far. Many respondents admit the expectation of losing some players over time and difficulty of new players' involvement, but also think that the game will continue thanks to the large card pool, stable mechanics, dedicated core community, offline or online. One of the main differences between online

games that close and offline games that go out of print, is that online games disappear, while cards still allow play to continue. As one of the interviewees emphasized "...just because CCP stopped publishing the game, cards will not stop working". Another similar comment from a forum poster read: "The game's not dead. CCP tactical teams are not going to abseil through your window just because you haven't burned your cards." [FP96] Similar to many in VTES community, we also hope that.

While the publisher ceases to make money after a CCG goes out of print, designers, especially of educational games would be happy to see their games in circulation and play for as long as possible. Therefore, we believe that observing the lifecycle of games that go out of print can inform educational game designers. Incorporating elements from games like VTES, which have developed loyal communities for years might help increase the impact of a serious game, by increasing its longevity, and the intensity of the community that develops around it.

## Endnotes

(1) \*SP = Survey Participant; IP = Interview Participant; FP = Forum Participant

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# Establishing a New Framework to Measure Challenge, Control and Goals in Different Game Genres

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**Abstract:** For over 40 years, researchers investigated utilizing video games for education. Some of that research focused on the type of pedagogical content to embed in a game and how to integrate it, while others emphasized how to preserve the inherent intrinsic motivation in games. One of the many factors that could affect motivation and learning in video games is the different intrapersonal elements and attributes of games. In order to test those attributes' effect on motivation and learning we need to be able to define them and clearly establish a method for measuring them. The object of this study is to establish a framework for measuring three of these attributes, Challenge, Control and Goals, based on user perception. This framework is an initial step to establish a clear metric for measuring those attributes in five different game genres: First-Person Shooter, Racing, RPG, Arcade and Sports.

## Introduction

Understanding video game design and analysis is tough, because of the distinct features of each genre (and each game for that matter). That distinctiveness makes it difficult to assess a standard for game design and evaluation that would apply to all games. A design and analysis strategy that might apply to an *RPG* game might not apply to a *Racing* game, and in some cases might not apply to another *RPG* game. In this study, we used the game player's perception of the game's features and attributes as a measurement to assess and analyze a game.

We started by breaking down intrapersonal game features and attributes into six separate classes based on previous research. We then selected a subset of those classes (Challenge, Control and Goals) and described how each class is present in video games. We generated a set of questions based on those descriptions to define our first survey. The first survey aimed at determining user experience in a generic game and not any particular genre. We used the results from that survey to establish our generic game metric for those classes.

We then used that metric and created a mapping for each of those descriptions to five commonly used game genres: *First-Person Shooter*, *Racing*, *RPG*, *Arcade* and *Sports* genres. That mapping provided us with the list of questions for our second survey. Similar to the first survey, the second survey asks about user experience but specific to each genre. We analyzed and assessed the results of the second survey to create our CCG Framework, which provides a metric for Challenge, Control and Goals in different game genres based on user perception.

In our conclusion and future works section, we discuss our upcoming studies and their relation to this research. We also recommend a few directions for future studies. For this study we used the terms game and video games interchangeably. We also refer to game attributes (defined in the next section) as attributes, features, elements, dimensions, categories or characteristics.

## Game Attributes

Breaking down the game into its primary attributes is essential to analyzing the game design and experience. With respect to motivation, Malone (1980) identified three primary features: Challenge, Curiosity and Fantasy. He branched out each feature into many sub-attributes but maintained that those three are the main categories of attributes. Malone later expanded on his classification in Malone & Lepper (1987) to two categories: Intrapersonal (Challenge, Curiosity, Control and Fantasy) and Interpersonal (Competition, Cooperation and Recognition). Gredler (1996) considered the Task, User, Goals and Control as the essential elements to a game. Alternatively, de Felix and Johnston (1993) divided the game structurally into Visuals, Interactions, Rules, and Goals. Malone & Lepper's (1987) intrapersonal category is later expanded and defined into six different Game Dimensions in Garris et. al. (2002). Garris defined the game dimensions as follows:

- **Fantasy:** Context, themes or characters.
- **Rules/Goals:** Rules, goals and feedback.
- **Sensory Stimuli:** Visual or auditory.
- **Challenge:** Level of difficulty.
- **Mystery:** Information complexity.
- **Control:** Player's control.

While other studies exist and provide their own definitions, the Garris classification of the game attributes seemed to be the most comprehensive when it comes to expanding on previous work and providing a sound break-down of the different game features. In this study we relied on the Garris definition to provide us with a direction in obtaining our own definitions of the different game attributes.

Analyzing the Fantasy, Sensory Stimuli or Mystery elements of a game proved difficult to map into simple survey questions and since there was no existing work done on providing a metric for those dimensions, we decided to select the remaining three attributes only (shown in table 1). Selecting only Challenge, Control, and Goals does not imply that Fantasy, Sensory Stimuli, and Mystery are not significant or relevant; rather, they proved to be too large for the scope of this study. In fact, we highly recommend future work to tackle those attributes and provide an extension to the CCG Framework.

Attribute	Description
Challenge	The difficulty level of the game, ranging from too easy to too difficult.
Control	Answers the question, how much control does a player perceives, that they have over the game? Do they have many options for which direction to head or which objective to complete or are they bound to a few?
Goals	Defined by short and long term objectives. Ranging from immediate (jumping a pond, defeating an immediate threat, etc) to longer-term objectives (finishing a chapter, unlocking a weapon, etc).

**Table 1: Intrapersonal Game Attributes**

### **Challenge**

Challenge is simply defined as the difficulty level of a game. If the game is too difficult, then the players will be frustrated with the game-play which brings down their enjoyment level. If the game is too easy then the players will be bored with their experience, again bringing down the enjoyment level. Grey et. al. (2011) argued that “challenge must be balanced and re-balanced perfectly in order to achieve and maintain flow and the motivation it provides.”

That “flow” is often difficult to achieve. Piselli et. al. (2006) argued that his results show that players should only win by a small margin and when that margin becomes larger, their in-game enjoyment levels decrease. Of course setting up a game that is not too difficult and not too easy might not be as simple as it sounds because that depends largely on the player’s game experience, abilities and frequency of playing this particular game.

For this study, we considered the difficulty of a game to be directly proportional to the number of attempts the user makes to finish a task in the game. (“Task” is used here to describe a subset of the game: a level, a fight, a race, a match, or any significant objective.) We deemed a game difficult if users fail to complete the tasks in that game repeatedly and feel frustrated. In contrast, we deemed a game easy if the tasks in a game are finished easily without requiring repeated attempts.

### **Control**

Control has many interpretations. Malone & Lepper (1987) argued Control is synonymous with self-determination and cited DeCharms (1968) that it is “a basic human tendency to seek to control one’s environment” and control your “actions and choices.” They also argued that it is “the perception of control, rather than the objective level of actual control, that is the important psychological variable of interest.” Garris et. al. (2002) defined Control as “the ability to regulate, direct or command something” and he argued that when players are allowed to choose between strategies and directions and make their own decision that will directly affect the outcome of the game it gives them a sense of “personal control.”

For this study we defined control as the choice between directions and objectives presented to the user at any given time. Increased control implies a greater number of choices of directions that could change the flow of the game and of the ordering or prioritizing of objectives to be accomplished in the game.

## Goals

We considered Goals in games as the set of objectives required by the game for the user to finish a task. Goals are a bit problematic to clearly distinguish because of overlap with other attributes, primarily Control, Mystery, and Challenge. Garris et al. (2002) argued that “clear and specific goals” lead to “greater attention and motivation.” For this study we distinguished short-term goals and long-term goals. Short-term goals refer to the more immediate objectives or as in Malone & Lepper’s (1987) terminology, “proximal goals.”

Short-term goals can be distinguished from Control objectives because they are usually user-defined where Control objectives are often explicitly stated and provide an option to the user to choose from a list. An example of a short-term goal in a First-Person Shooter game is “overpower the sleeping guard and do it quietly so I don’t alert any other guards and have them raise the alarm.” Examples of Control Objectives in First-Person Shooter are “kill the guards,” “don’t get caught,” and “detonate an explosive.”

Long-term goals are usually defined on a different scale. They are widely considered as the ultimate objectives of a task. In a First-Person Shooter genre, a long-term goal could be to finish the level, while in an RPG genre the long-term goal could be killing the boss. In this study we considered long-term goals to be the union or result of all the short-term goals and Control Objectives.

## First Survey: Providing a Metric for a Generic Game

Using the definitions for the game attributes we listed in the previous section, we formulated a survey questionnaire to determine user perception of those attributes for a generic game. The survey questions (shown in Table 2) were intended to distinguish user experience in good games versus bad games and identify how each experience is translated in terms of Challenge, Control and Goals. It is important to note that terms like “hard,” “easy,” “good” and “fair” were defined to the participants as their perception of the game. The results here are not intended to be viewed universally, rather they only reflect the perception of respondents.

We also asked the participants some demographic questions to give us data on their age, gender, education, game-play frequency and overall experience. For this study, we only considered results from players who play video games three or more hours a week to ensure integrity of the data. Players who do not play video games often will have different scales of optimal Challenge, Control and Goals and might lack accuracy of perception if it has been a while since they last played video games. The survey invitation was sent to six mailing lists for video game academics or enthusiasts.

Number	Type	Question	Options
1	Challenge	In a “hard” game, how many tries does it take to finish an average level? We understand some levels are harder than others, that is why we want your average.	(1-15+)
2	Challenge	In a “easy” game, how many tries does it take to finish an average level? We understand some levels are harder than others, that is why we want your average.	(1-15+)
3	Challenge	In an optimal game, how many tries does it take to finish an average level? We understand some levels are harder than others, that is why we want your average.	(1-15+)
4	Control	In an optimal game, what is the ideal number of directions you should be able to choose from at any given time? Choosing a certain direction means changing the flow of the game, like going down the flowerpot tunnel in Super Mario or choosing one path over another in Zelda.	(1-15+)
5	Control	In an optimal game, what is the ideal number of objectives you should be able to choose from at any given time? Objectives are the list of tasks you need to achieve in order to complete a level or the game like retrieving an item, killing an enemy, winning a race, etc.	(0-15+)
6	Goal	In an optimal game, how many short-term goals you should have at any given time? (like jumping a pond or killing an immediate enemy)?	(0-15+)
7	Goal	In an optimal game, how many long-term goals you should have at any given time? (Like finishing a chapter or unlocking a much sought after weapon)?	(0-15+)

**Table 2: First Survey Questions**

## Results

We published the survey for one week and during that week we received 87 responses. While there were a number of outliers in our result set, the data was very informative.

Out of the 87 respondents, 94% of survey takers said they play video games three or more hours a week and 100% of them said they have played video games for five or more years. 68% of our survey takers had at least a Bachelor's degree while 100% have finished high school. 72% of the respondents were male and 87% of them were between the ages of 18 and 40. Here are some of our findings:

- Challenge: 86.2% of respondents felt that an optimally challenging game should take a player 2-5 attempts to finish a level of a generic game.
- Control (Directions): 82.8% of respondents felt that an optimal game allows the user to choose between 2-5 directions at any given time.
- Control (Objectives): 74.7% of respondents felt that an optimal game allows the user to choose between 3-5 objectives at any given time.
- Goals (Short-Term): 63.2% of respondents felt that an optimal game provides its users with 2-6 short-term goals at any given time.
- Goals (Long-Term): 49.4% of respondents felt that an optimal game provides its users with 2-6 long-term goals at any given time.

It is clear that the data is less informative with regards to the Goals attribute but still favors the observations above. It is also important to note that 17.2% of users felt that a good game provides 15 or more long-term goals at any given time. That discrepancy could be attributed to the varying opinions on game experiences.

Based on the result set, we created an initial CCG Framework that is applicable to a generic game but not specific to any genre (shown in Table 3). Since there was no overwhelming value for any of the attributes based on user perception, we chose a 3 or 4 value range that covers the maximum total value.

Attribute	Questions	Legend
Challenge	1. On average, how many tries does it take you to finish a level?	2-5
Control	1. On average, how many objectives were you able to choose from at a given time?	3-5
	2. On average, how many directions were you able to choose from at a given time?	2-5
Goals	1. On average, how many short-term goals did you have at any given time (like jumping a pond or defeating an immediate enemy)?	2-6
	2. On average, how many long-term goals did you have at any given time (like finishing a chapter, or unlocking a sought after weapon)?	2-6

**Table 3: Generic CCG Framework**

## Second Survey: Mapping the Metric to Specific Genres

After determining our generic CCG Framework, we formulated the second survey to specialize it to these five genres: First-Person Shooter, Racing, RPG, Arcade and Sports. There doesn't exist a standard game genre classification but previous work does have overlapping definitions. Laird & van Lent (2001) used Action, Role Playing, Adventure, Strategy Games, God Games, Team Sports and Individual Sports for their study while Apperley (2006) contended that Simulation, Strategy, Action and Role Playing are the main defining genres.

Our list is not complete but does seem to cover a wide range of the genre spectrum. However, we do not presume that other genres do not exist or are not significant, just that they are outside of the scope of this study. We encourage further study to cover other genres beyond the five we cover here.

For the second survey, we mapped our first study questions onto the five genres. We also removed the "hard" and "easy" challenge questions, because at this point we are primarily concerned with optimal games and previous survey data was not very informative for "hard" and "easy" games. The survey invitation was mailed to the same mailing lists as the first survey. We have 25 survey questions for the second study. In the questions, the term "level" was changed to "race" for Racing genres, "solo boss fight"

for RPG genres, and “a game segment” for Sports genres. We retained “level” for both First Person Shooter and Arcade genres. We also included the same demographic questions from the first study.

## Results

Similar to the first survey, we published the second survey for a week, during which we received 77 responses. For most of the genres, user perception was very similar to the generic game in the first survey, with some small differences.

Out of the 77 respondents, 75.3% were male, 100% between the age of 18-63 and 89.6% with a college degree. Only 1 of the 77 survey takers played video games less than 3 hours a week and only 3 had been playing video games for less than 5 years. Here are the key observations:

- Challenge: 80.5% of users suggested that *First-Person Shooter* games take 2-5 attempts per an average level. Similarly, 80.5% answered 2-5 attempts to finish in a top 3 of a race in a *Racing* game. 96.1% of the users answered that finishing an average boss fight in an *RPG* game takes 1-5 attempts, while 89.6% said the same about finishing a game segment in a *Sports* game. Finally, 84.4% claimed that an average level in an *Arcade* game takes 2-5 attempts.
- Control (Directions): 92.2% said that *First-Person Shooter* games should give the option between 1-5 directions at any given time. In a *Racing* game, 84.4% of users suggested that a player always has the choice between 2-5 directions. That number dropped to 72.7% for an *RPG* game. 79.2% said the same about *Sports* games. 81.8% also said the same about *Arcade* games.
- Control (Objectives): Having 2-5 objectives at any given time was supported by 93.5% for *First-Person Shooter* games and 85.7% for *RPG* games. However, the percentage of users that claimed 1-5 objectives at any given time for a *Racing* game was 93.5%, a *Sports* game was 89.4%, and an *Arcade* game was 93.5%.
- Goals (Short-term): For *First-Person Shooter* games, 85.7 % of users suggested that a player always has 1-6 short-term goals. That number went up to 88.3% for *Racing* games. Similarly, 79.2% said the same about *Sports* games and 85.7% about *Arcade* games. 75.1% say 2-5 short-term goals are available to a player at any given time in an *RPG* game.
- Goals (Long-term): 75.3% claimed *First-Person Shooter* and *Racing* games provide 1-5 long-term goals at any given time. That number drops to 71.4% for *RPG* games, at 80.5% for *Sports* games and finally at 87.0% for *Arcade* games.

Number of	FPS	Racing	RPG	Sports	Arcade
Attempts	2-5 in a level (80.5%)	2-5 (top 3) in a race (80.5%)	1-5 in a boss fight (96.1%)	1-5 in a segment (89.6%)	2-5 in a level (84.4%)
Objectives	2-5 (93.5%)	1-5 (93.5%)	2-5 (85.7%)	1-5 (89.4%)	1-5 (93.5%)
Directions	1-5 (92.2%)	2-5 (84.4%)	2-5 (72.7%)	2-5 (79.2%)	2-5 (81.8%)
Short-term Goals	1-6 (85.7%)	1-6 (75.1%)	2-5 (80.5%)	1-6 (79.2%)	1-6 (85.7%)
Long-term Goals	1-5 (75.3%)	1-5 (75.3%)	1-5 (71.4%)	1-5 (80.5%)	1-5 (87.0%)

**Table 4: Genre-Based CCG Framework**

## CCG Framework

Based on the results of the second survey, we compiled our Genre-based CCG Framework (shown in Table 4). The Genre-based CCG Framework focuses on a 3-5 value range which maximizes the number of responses. This Framework can be used as a tool to measure experienced gamers’ perceptions of Challenge, Control and Goals in an optimal game in those genres.

## Future Work

This study is the first of its kind to measure user perception for Challenge, Control, and Goals for optimal games. We argued that the end result, the CCG Framework, will help researchers and designers to measure user perception in a quantitative manner. It does not mean, however, that there is no room for improvement. One expansion on the CCG Framework could cover the other three attributes we identified from the literature (Fantasy, Mystery and Sensory Stimuli). Another expansion can cover the interpersonal attributes not examined within the scope of this study, like Cooperation, Collaboration and Competition.

Future studies can also test user perception immediately after game-play by comparing the CCG Framework to empirical data from a user study. We have recently started two such studies. One study is aimed at testing the Challenge parameter of the CCG Framework in an educational game called "Policy World." Another study is being designed to empirically verify the CCG Framework with data based on user perception immediately after game-play for all five genres.

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# **Do Girls and Boys Come From Different Planets? Gender Differences in Educational Games**

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**Abstract:** Research shows that, on an average, a teenager spends 14 hours per week playing video games. But there are studies that say that there is a discrepancy between male and female counterparts in their attitude towards video games in general. According to the entertainment Software Association (ESA), the number of girls vs. boys as video game players is changing in the recent times. This study investigated the following research questions: (1) Do instructional games augment learning for both female and male students? (2) What is the impact of the challenge and fantasy features in instructional games on learning for both female and male students? The overall result shows that the gender has no significant impact on learning. But the gain score for the female students who played a version of the game, in which fantasy turned-on is significantly higher than male students.

## **Introduction**

Students' achievement in math and science is on the decline in the United States. National Academies (2007) mentions "the critical lack of technically trained people in the United States can be traced directly to poor K–12 mathematics and science instruction" (p. 114). Further, it elaborates "few factors are more important than this if the United States is to compete successfully in the 21st century" (p. 114).

Why is investing in science and math education important? National academy of Sciences in their 2007 report entitled *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, answered this question in the following manner: "today, much of everyday life in the United States and other industrialized nations, as evidenced in transportation, communication, agriculture, education, health, defense, and jobs, is the product of investments in research and in the education of scientists and engineers" (p. 41).

## **Educational Games in Science Education**

Learning through games is not a new phenomenon. According to Bradshaw and Lowenstein (2007) the use of games for learning is a rather ancient technique. For example, games were used to coach soldiers for war. For the past three decades scholars (Nelson, 2008; Terenzini & Pascarella, 1994) predicted that traditional tools such as class lectures, reading and writing assignments, tests, field trips, discussions, laboratory reports, and such others, for teaching science may not be effective teaching tools. On the contrary, new instructional techniques such as using video games make "players think, talk, and act" and their rich virtual environments are what make games powerful contexts for learning (Shaffer, Squire, Halverson, & Gee, 2005). Squire and Jan (2007) said that schools lag behind in producing appropriate learning in today's knowledge-based economy:

Science education needs to prepare students for a future world in which multiple representations are the norm and adults are required to 'think like scientists.' Location-based augmented reality games offer an opportunity to create a 'post-progressive' pedagogy in which students are not only immersed in authentic scientific inquiry, but also required to perform in adult scientific discourses. (p. 5)

While concluding, Squire and Jan mentioned that augmented reality games on handhelds "hold the potential for engaging students in meaningful scientific argumentation" (p. 5). The same idea was reiterated by Goodman (2007), that a game-based education might actually prepare students to face real world problems.

## **Study Purpose**

This study has two main purposes: first to find out whether instructional games support effective learning for both female and male students, and secondly to determine whether the factors of challenge and fantasy in instructional games impact learning outcomes. The theoretical framework for educational games is based on constructivism. One of the main tenets of constructivism is that students construct their own knowledge. As Bruner (1966) mentions:

The will to learn is an intrinsic motive, one that finds both its source and its reward in its own exercise. The will to learn becomes a 'problem' only under specialized circumstances like those of a school, where a curriculum is set, students confined and a path fixed. The problem exists not so much in learning itself, but in the fact that what the school imposes often fails to enlist the natural energies that sustain spontaneous learning. (p. 127)

It is evident from Bruner that educators need to provide environments that would intrinsically motivate students to construct their own reality. Games are intrinsically motivating. That is there is no external reward needed for the intrinsic motivation. But the experience of the activity in itself is gratifying. Salen and Zimmerman (2004), said that games provide pleasure, which is intrinsic and that cannot be easily explained but something people desire to experience. Some might argue that players play games to win. If winning is the sole motivation for participating in games, probably the Olympics by this time would have been reduced to an arena of couple of dozen countries. Several countries participate in the Olympics despite not getting even a single medal for several years, because they want to participate in the game for the sake of participation. Such a naturally motivating technique can be effectively used in learning environments.

### **Essential Features of an Educational Game**

There are scholarly articles (Malone, 1981a; 1981b; Malone & Lepper, 1987; Dickey, 2005; Kirkley & Kirkley, 2005; Shaffer, 2007) published in the last 30 years that mention the important features of games. Malone's (1981) seminal work, which has been quoted in many scholarly articles, identified three important characteristics of intrinsically enjoyable computer games:

1. Challenges
2. Fantasy
3. Curiosity

In the Curiosity category, Malone mentioned that informative feedback is one of the specific principles needed for designing games. There is sufficient literature to support the role of feedback in an instructional environment. The current study was intended to find the impact of challenge and fantasy in an instructional game.

### **Challenge**

Studies show that challenging activities improve student engagement not only in games but in classrooms as well. Shernoff, Csikzentmihalyi, Schneider and Shernoff (2003) concluded that students experience increased engagement when they encounter a highly challenging activity and perceive that they have the appropriate skills needed to complete the task.

After conducting a study that involved more than 40 educational games, Dempsey, Haynes, Lucassen and Casey (2002) reported that "learners are likely to sustain interest in games that are challenging and goal oriented" (p. 166). Fong-Ling, Rong-Chang and Sheng-Chin, (2009) concluded, after evaluating four instructional games, that challenge is one of the main factors that makes an educational game effective. Lucas and Sherry (2004) studied gender differences in video game play and reported that for both male and female players, challenge is one of the top-ranked gratifications to play a game. Video game players enjoyed being faced with challenging and competitive circumstances and it was one of the fun elements of video games (Vorderer, Hartmann & Klimmt, 2003). The human need to have challenges is rooted in a desire to achieve, which goes back to McClelland, Atkinson, Clark, and Lowell (1958) theory of achievement. McClelland et al. (1958) defined the need for achievement as "success in competition with some standard of excellence. That is, the goal of some individual in the story is to be successful in terms of competition with some standard of excellence" (p. 181). This idea was echoed by Daft (2008) who says that achievement is "the desire to accomplish something difficult, attain a high standard of success, master complex tasks, and surpass others" (p. 233).

### **Fantasy**

Cassell and Ryokai (2001) posited that fantasy plays an important role in a child's development. Through fantasy activities such as role-playing, dress-up, and storytelling with objects such as stuffed animals, children explore different possibilities in their life without the

risk of failure and frustration. Thus fantasy plays an important role in children's emotional and social development. Further, fantasy also fosters children's cognitive and language skills. By fostering the development of children's symbolic imagination and providing a field for its exercise, fantasy play and narrative activity prepare the way for the development of abstract thinking and higher mental processes (Cassell & Ryokai, 2001).

Kenny and Gunter (2007) argued that it is essential for both game designers and instructional designers to use the fantasy feature properly. Fantasy plays an important role when a player decides whether to play a game or not. Players might choose a game that has a strong and interesting fantasy. Similarly, in an educational context also, learning content coupled with fantasy is more appealing and leads toward a better retention of the modules learnt (Kenny & Gunter, 2007). Game designer Marc LeBlanc (2004) defined fun using eight different terms and fantasy is one of them. He said fantasy is the make-believe aspect of a game that resonates with the gamer and thereby makes the game more enjoyable.

## **Study design**

Studies that include more than one factor or variable are known to follow factorial design. In this study, following are the independent variables:

1. Features (has four levels: challenge on, fantasy on, both on and none on),
2. Gender (has two levels: Female and Male)

To find out the main effects of features, a univariate analysis was used. To find out the individual differences the researcher used the X x Y factorial design model in this study. Factorial design not only tests the significance of group differences (due to the levels of the IVs), but also tests for any interaction effects between levels of independent variables (Mertler & Vannatta, 2010). In the current context, factorial design not only tests how challenge and fantasy features affect the learning outcome, but also tests the combined effect of gender on the learning outcome measured by the gain score.

A game called *Humatan* was created to teach human anatomy to high school students. *Humatan* is an instructional game where high school students will learn to identify and assemble human skeletal structures. This game is specifically developed to address the following standards of Baltimore County Public Schools (BCPS) curricula:

1. Para-medical Biology: The Human Body (20.4)
2. Human Anatomy: Support, Protection and Movement (12.3) of the BCPS Curriculum

## ***Humatan* game**

It is 1369 BC. King Akhenaton is Egypt's ruler, with Queen Nefertiti by his side. They don't have any children yet. A learned scribe has told the King that the ancients had been aware of this time, and had with their immense skills created two little human bodies, that of a male child, and a female child, with all the body parts, separated and hidden away in the royal palace rooms long ago. This scribe knew how to pray to Lord Anubis to bring the children back to life, provided they could find for him or her all the body parts, which were hidden in the palace, and assemble them together.

It is now up to the player to find all the parts, and get them to the courtroom, and fix them correctly to make the new heir to the throne come alive. The player is made aware that during the quest there could be all sorts of danger lurking everywhere.

The *Humatan* game was made in such a way that the various instructional aspects (variables) were turned on and off. Following four variations of the game were created and students were randomly assigned to play each variation of the game:

1. One game with Challenges alone (No fantasy)
2. One game with Fantasy alone (No challenges)
3. One game with both variables
4. One game with none of the variables

The game was tested by the BCPS Office of Science PreK-12 for its content and usability. Students initially took a pretest and played the *Humatan* game followed by the posttest. Both pre and posttests consist of following tests:

1. Identification test (to assess student ability to identify the skeletal parts)
2. The Terminology test (to assess whether students could identify the bone and its common name)
3. Comprehension test (to evaluate students' knowledge of specific parts of the human body associated with specific skeletal structure)

## Results

A total number of 254 students from nine high schools in BCPS participated in the study. Out of 254 students, only 202 students successfully completed all the steps (taking the pretest, playing the game and taking the posttest) of the data collection. The remaining 51 students took only the pretest and played the game, but were unable to complete the posttest. Out of 202 students, 121 were female and 79 were male and 2 students did not report their gender.

### Statistical analysis

Reliability test for the pretest and posttest was conducted and the Cronbach Alpha coefficient was .889, which shows that both tests have a good internal consistency by conventional standards.

A paired samples t-test was conducted to see if there is a significant difference between the pretest and posttests and the findings are reported in Table 1:

	Mean	N	Std. Deviation	Std. Error
				Mean
Pre Score	11.80	202	5.703	.401
Post Score	15.20	202	5.892	.415

**Table 1: Paired Samples Statistics**

From the paired samples t-test results we can see that there was a significant difference in the posttest scores ( $M=15.20$ ,  $SD=5.892$ ) and the pretest scores ( $M=11.80$ ,  $SD=5.703$ );  $t(201) = -13.182$ ,  $p = 0.000$ . These results suggest that *Humatan* game does facilitate learning. Specifically, the results suggest that when students play an instructional game, their learning does increase as reported in the posttest scores. Also, there is a strong positive correlation ( $r = .800$ ), which indicates that the students who did well on the pretest also did well on the posttest.

### Gender

A two-way between-groups analysis of variance was conducted to find the effect of game features and gender on gain score. A total of 121 female students and 79 male students participated in the study. Table 2 shows the mean scores of each gender in different game versions. Four groups of students played four different versions of the game containing the following features: Both On, Challenge On, Fantasy On, and None On.

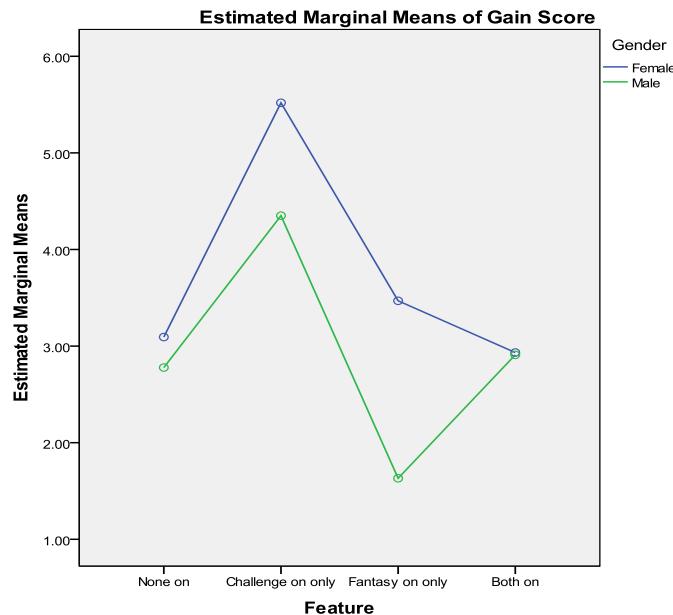
*Dependent Variable: Gain Score*

Feature	Gender	Mean	Std. Deviation	N
None on	Female	3.0938	3.37313	32
	Male	2.7778	3.60646	18
	Total	2.9800	3.42553	50
Challenge on only	Female	5.5185	3.57739	27
	Male	4.3500	2.94288	20
	Total	5.0213	3.33942	47
Fantasy on only	Female	3.4688	4.71774	32
	Male	1.6316	3.33684	19
	Total	2.7843	4.31423	51
Both on	Female	2.9333	2.91173	30
	Male	2.9091	3.39340	22
	Total	2.9231	3.09234	52
Total	Female	3.6942	3.80973	121
	Male	2.9367	3.39812	79
	Total	3.3950	3.66279	200

**Table 2: Descriptive Statistics**

The interaction effect between gender and game feature was not statistically significant,  $F(3, 192) = .65, p=.59$ . There was a statistically significant main effect found for feature  $F(3, 192) = 4.26, p=.006$ . Post-hoc comparisons using the Tukey HSD test indicated that the mean score for the challenge feature ( $M = 5.02, SD = 3.43$ ) was different from none on feature ( $M = 2.98, SD = 3.43$ ). Both on ( $M = 2.92, SD = 3.09$ ) and Fantasy on ( $M = 2.78, SD = 4.31$ ) features did not differ significantly from either challenge or none on. The main effect of gender,  $F(1, 192) = 2.61, p=.11$ , did not reach statistical significance.

Figure 1 is a graphical representation of the mean gain scores achieved by male and female students for different variations of the Humatan game.



**Figure 2: Profile plots for the different variations of the Humatan game based on gender**

## Discussion

Current study results show that games with challenges make students learn better, probably because they feel a sense of achievement irrespective of their gender. On the other hand, fantasy feature helped female students to learn better ( $M = 3.46$ ) than the male students ( $M=1.63$ ). As mentioned earlier, the interaction effect between feature and gender did not attain statistical significance, which shows us that there is no significant difference between male and female students in the overall increase in achievement scores.

This study results are in concurrence with those studies in which no significant difference was found between the male and the female students while using an instructional game. Annetta, Mangrum, Holmes, Collazo, and Cheng (2009), in their study did not find any significant difference between male and female subjects. Similarly, Ke and Grabowski (2007) tested the differential effect of games on the math achievement of 5th-graders of two genders. The study did not observe the main effect for gender or interaction effects between gender and computer games on the math achievement of 5th-graders. Papastergiou (2009) investigated the effects of computer games on science achievement of 88 high school students and found no gender-based differences.

From the current study results we can conclude that challenge is a very important feature and it positively augments learning in an educational game. Endogenous fantasy is a helpful hook to attract the students (especially female students) towards an educational game. However, if the fantasy element is too compelling, then the game might become less educational, and more entertaining, which is inferred from the low gain scores of the male students. Individual differences due to gender was not significant in the study, which tells us that the importance of design features is extremely crucial for a successful instructional game and if the game features are properly designed, then the individual differences among the students do not impact the learning significantly.

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# ***Games of Bones: Design Decisions and Early Feedback from a Prototype***

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**Abstract:** In order to enliven “life through time” exhibits that are standard in most natural history museums, an interdepartmental team from the Field Museum of Natural History is creating a web-based game called *Game of Bones* (GoB). GoB is implemented in Unity 3D for maximum flexibility and is intended for use both within museum exhibits and remotely. When completed, GoB will 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. Gameplay will replicate 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’ ecologies, and making virtual museum exhibits. Here, we discuss design decisions and focus group feedback from the initial prototype of the game.

## **Introduction: Enlivening “Life through Time” Exhibits**

Many natural history museums feature “life through time” exhibits. In these exhibits, a visitor walks past dioramas that reconstruct communities at particular points in Earth’s history, presenting a broad overview of evolution and the history of life. A typical visitor to such exhibits might focus on the more charismatic reconstructions (Tubutis, 2005), like dinosaurs of the Mesozoic Era. Indeed, dinosaurs attract so much visitor attention that many museums devote the greatest amount of square footage to them in “life through time” exhibits and often separate them out into their own sections or complementary exhibits (e.g., the American Museum of Natural History or the Denver Museum of Nature and Science). The Field Museum of Natural History’s (FMNH) “life through time” exhibit, Evolving Planet, opened in 2006 after a major re-design, and features over one thousand fossil specimens, dioramas, videos, and reconstructions of fossil species. The exhibit covers life from its origins to the last ice age and features a large space devoted to dinosaurs. Visitor time spent in these dinosaur sections is often at the expense of other equally important but lesser known periods in Earth’s history.

An interdepartmental FMNH team is creating a web-based game that can complement and augment the visitor experience in a “life through time” exhibit such as Evolving Planet. This game will enliven the exhibit and bring attention to all periods of Earth’s history, not just ones with charismatic animals such as dinosaurs. A primary goal for this prototype game is to expand players’ experiences by giving them insight into the research performed by museum scientists and emphasize the key role that natural history collections have in scientific inquiry. Once completed, the 10-level game will focus on seminal moments in Earth’s history. Given that “life through time” exhibits showcase similar seminal content, a major design goal is broad-scale usability of the game by museums and science centers around the country, and possibly the globe.

## ***Game of Bones***

To test the concept and design for a “life through time” game, FMNH produced a prototype called *Game of Bones* (GoB). GoB is aimed at middle- and upper-elementary school aged youth and families with the goals of allowing players to experience what it is like to be a paleontologist by replicating the activities of scientists that work in museums through engagement with museum research, collections, and exhibits. GoB has been prototyped as a single-player experience to focus the narrative and test different designs and basic mechanics. A collaborative or multi-player mode will be tested in future design iterations because collaborative gameplay would more closely mimic real scientific experience and promote greater learning. In the single-player prototype, GoB players unearth, prepare, and study important fossils in Earth’s history. Players also gain insight into the nature of scientific inquiry through topics such as anatomy, functional morphology, and evolution. Designed in Unity 3D, GoB will be made available at no cost through the Museum’s website and will be adapted for tablet devices to enable gameplay from within museum exhibits.

GoB is based on current and past paleontological research conducted by FMNH scientists, with an emphasis on scientific accuracy and the realities of field- and museum-based research. Designing games around real scientific research with a high degree of accuracy is critical for several reasons: 1) it simulates real-life scientific observations and experiences for players; 2) it allows players to mimic scientific processes in order to generate solutions to real-world questions; 3) it provides real-life scientific discovery moments and opportunities for higher-level engagement (Aronowsky et al, 2011). In the finished game, youth will use gameplay to learn how paleontologists work, investigate fossil specimens in museum exhibits and research collections, and gain insight into the nature of scientific inquiry and topics such as geography, evolution, anatomy, and functional morphology. We also seek to engender a positive attitude towards science in youth, a goal that is realistic given past success with paleontology-based digital learning programs such as I Dig Science (King et al, 2011; Steinkuehler and Alagoz, 2010). The GoB game design and mechanics are targeted towards youth aged 9–13 (approximately 4th–8th grades), but we anticipate that GoB will also appeal to family audiences. We envision the final game as having ten levels with varying degrees of difficulty. Each level will correspond to a different period in geologic time and will focus on an FMNH specimen and the research of an FMNH curator or collections manager. The prototype focuses on *Edaphosaurus* (Figure 1), a fossil mammal-relative from the Early Permian Period of Earth history (approximately 299 to 270 million years ago) and the research of Assistant Curator of Paleomammalogy Dr. Kenneth Angielczyk.

The Museum's departments of Education, Geology, and Biodiversity Synthesis Center worked with two recent graduates from Columbia College Chicago (a game designer and a graphic artist) to create the game prototype. The prototype is intended to exemplify the vision of the entire game by showing one fully playable stage that presents examples of game mechanics, graphics, science content, and learning goals. The prototype incorporates aspects of the virtual dig, research, and museum exhibit activities inspired by the I Dig Science summer program (see below), with the same attention paid to the scientific accuracy and realism of paleontological fieldwork and museum research.

### **Game of Bones**

The inspiration for GoB's design is the successful I Dig Science summer camp, an out-of-school time program for a small group of high school-aged youth that uses a suite of digital technologies in combination with real-world resources at FMNH. I Dig Science was created by FMNH and Global Kids in 2008 and provides opportunities for teens from disparate locations to use a participatory 3D virtual environment to communicate with scientists and conduct activities that mimic those of the scientists—including hunting for fossils, collecting data, testing hypotheses, and discussing and interpreting their discoveries. The GoB prototype is an attempt to engage larger groups of younger learners and families in a web-based game that captures some of the core science concepts and learning goals of I Dig Science.

In the prototype, players begin gameplay in a virtual museum office, based on a real space in the FMNH Geology Department. The office serves as the hub for all activities within the game and also provides players with a virtual behind-the-scenes look at the Museum. Our choice to use the office as a hub for the game was based on 1) the fact that it adds to the game's immersive environment, making players feel that they are scientists working in a museum; and 2) the contents of a typical curator's office (e.g., maps, references, specimen cabinets, workspace for studying fossils) consist of many items that lend themselves naturally to certain aspects of gameplay and that players will actively use in the game. After clicking the map (Figure 1), players are presented with a series of virtual fossil excavation sites around the globe to which they can travel. These dig sites are based on the real locations where FMNH researchers have ongoing projects or have worked in the past, emphasizing the diversity of work performed by Museum scientists. In the prototype, only one dig site can be selected. However, in the completed version of the game, a subset of localities will be available to the player at the start of the game, with additional localities becoming unlocked as players gain experience as a paleontologist. For the prototype, we chose to implement an example focusing on the mammal-relative *Edaphosaurus* (Figure 1), which is commonly found in Lower Permian rocks in Texas and Oklahoma (e.g., Reisz, 1986; Berman et al., 1997). Our decision to use *Edaphosaurus* reflects a large number of factors: 1) its distinctive and engaging morphology (e.g., it has a large sail on its back), 2) its evolutionary importance as one of the first terrestrial vertebrate herbivores (e.g., Reisz and Sues, 2000; Reisz, 2006), 3) the large number of *Edaphosaurus* specimens in FMNH collections, 4) a skeleton of *Edaphosaurus* is displayed in Evolving Planet and in most "life through

time” exhibits, and 5) Dr. Angielczyk’s research focuses on the paleobiology of ancient mammal-relatives (non-mammalian synapsids) such as *Edaphosaurus*.



**Figure 1:** Images from Game of Bones (from top to bottom, left to right) a. *Edaphosaurus* specimen from Field Museum, b. Office, c. Map, d. Dig site, e. Digging, f. Sort, g. Assemble, h. Research

Once a locality is selected, players hunt for fossils at their site, using the same tools that paleontologists use to excavate fossils in that area. For example, when digging in Texas, players use rock hammers, chisels and brushes, but if digging in the Antarctic, players will use jackhammers and saws. This portion of the game allows players to experience how paleontologists discover and excavate fossils, and understand the types of tools needed for fieldwork. The fossil excavation game mechanic should be compelling to players because it can conjure the sense of excitement and adventure learners often associate with paleontological fieldwork in exotic locations. The inclusion of

the virtual fossil dig in GoB also provides an accessible gateway to the game that may inspire players to further engage with it, even after they discovered their fossils.

After players have successfully excavated their fossils, they return to the office to sort and assemble their discovery. To maintain the exploratory feel of the game and prevent it from becoming overly linear, players can choose which task they want to accomplish first. When sorting, they use comparisons with real references from the scientific literature to help them sort their fossil pieces into the correct anatomical bins (e.g. skull, shoulders, pelvis). During assembly, players use their fossil pieces to reconstruct their ancient animal. Our goal for these mechanics is in part to enrich the simulation of being a scientist, since organizing, preparing, and identifying fossils are important steps in the follow-up work after an expedition. The sorting process also emphasizes how scientists use previous work in the literature to inform their research, and provides a seamless way for players to begin thinking about the anatomy of their fossil animal and how it may be similar to or different from the anatomy of other fossil and extant animals. In particular, the comparisons with literature sources emphasize our homology learning goal (i.e., homologous structures are equivalent because of their common evolutionary origin even if they appear somewhat different due to functional overprinting). The assembly mechanic gives players the opportunity to apply what they may already know about anatomy, or have learned during the sort process, with the visual reward of seeing their animal come together through their efforts.

Once they have sorted and assembled their fossil animal, players are challenged to develop and test hypotheses about its biology, ecology, and functional morphology. To provide insight into the key role that museum specimens play in scientific research, one of the main mechanics of this stage of the game consists of players using the “research collection”, where they find photographs of relevant parts (e.g., skulls, jaws, limb bones) of both extinct and extant animals. By making observations of important features (e.g., tooth and skull shape in regards to dietary preference), and synthesizing these data with additional information provided during the game and knowledge that they already have, players can make inferences about the lifestyle of their fossil animal. In the prototype, gameplay in this stage focuses on answering the question “What did your animal eat?” This allows players to experience how paleontologists reconstruct the biology and ecology of extinct animals and to also gain insight into topics such as the form-function relationship that exists in many organisms (e.g., shearing teeth are needed to slice meat). Although our focus group testing (see below) showed that the game mechanics of this stage are fundamentally sound, time and funding constraints limited our implementation to only including photographs of comparative specimens. As our development of the full game proceeds, we hope to replace the photographs with fully-rendered objects comparable to the fossil specimens that players excavate and study, which will help to make this stage more engaging.

The game concludes with an often overlooked aspect of the scientific process: presenting one’s results and conclusions to peers and the general public. This mechanic takes the form of players building a virtual museum exhibit about their fossil animal. The museum exhibit format was chosen because it combines a way for players to integrate all aspects of their previous gameplay (including their fully reconstructed fossil and their conclusions about its biology and ecology) in a format that is interesting, familiar, and that ties their experiences back to a museum context.

### **Youth Focus Group Feedback and Surveys**

The preliminary learning goals of GoB are for players to understand paleontological fieldwork and research, what museum collections are and how they are used, basic anatomy and the principle of homology, the functional morphology of living things, and the nature of scientific inquiry. Table 1 outlines eight preliminary learning and attitudinal goals for GoB and how they map to gameplay in the prototype. These goals may be modified or expanded in future iterations of the game.

Learning Goal	Game Mechanic
1. Understand the distribution of fossils in time and space	Using Map
2. Understand the realities of paleontological field work – types and conditions of fossils	Digging Fossils
3. Know some of the tools & technology used for paleontological dig	Digging Fossils
4. Understand basic anatomy and the principle of homology	Sorting, Assembling & Researching Fossils
5. Apply logic/comparative methods to solve a problem	Sorting & Assembling Fossils
6. Understand what museum collections are and how they are used	Researching Fossils
7. Understand the function of living things (functional morphology)	Researching Fossils
8. Have a positive effect towards science, feel a empowered in science	Overall Game Play

**Table 1: Game of Bones Learning Goals**

An early version of the prototype was tested with a youth focus group of twenty-three 6th grade students in November 2011. We administered pre- and post-play surveys to better understand what youth players were gleaning from gameplay. Fourteen of twenty-three (60%) players had a positive change in their understanding and description of the realities of paleontology fieldwork (learning goal #2). All but one participant demonstrated an understanding of the tools used by paleontologists post-gameplay (learning goal #3). All but two participants showed positive change in knowledge about vertebrate anatomy (learning goal #4), and these two participants had no change between the surveys as they demonstrated a sound comprehension of anatomy in the pre-play survey. All players were able to apply logic in problem solving (learning goal #5), although 83% (19/23) demonstrated this skill in the pre-play survey. All but one player were able to articulate why museums have and need research collections in the post-play survey (learning goal #6). Seventy percent of players showed positive change in their ability to evaluate anatomical function post-play (learning goal #7). There were no differences in attitudes towards science because both pre- and post-play survey responses were uniformly positive towards science with all youth able to articulate specific ways in which science benefits the world (learning goal #8). Given that the prototype focuses on a single geological time period, we did not evaluate students' understanding of geological time and the distribution of fossils in time and space (learning goal #1).

From these preliminary data, we see areas where the current design of GoB can have a positive impact on learning. Gameplay may help 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 5) the ability to evaluate anatomical function. Based on preliminary data, GoB might not have a positive impact on a player's attitude towards science or ability to apply logic to solve a problem because interest-driven players may already have achieved these two goals.

For the youth focus group, we solicited feedback about gameplay and mechanics (what worked and what did not) and if and where players envisioned themselves playing the completed ten-level game. Critical feedback from youth players indicated they wanted to play more and have more levels (the most common comment was "make the game longer"). Most youth players indicated that they would enjoy playing a full version of GoB from home, which is interesting considering that these same players most frequently played sports games such as *Madden 12*, shooter games such as *Call of Duty: Black Ops*, and physical games such as *Just Dance 2* at home. Very few youth players indicated they would play GoB in a museum setting. More focus groups and a different testing design would be necessary to tease apart 1) if youth do not currently associate natural history museums with digital gameplay; 2) if youth players cannot envision playing a digital game from within a museum because they currently lack the technology to do so; or 3) if youth would not play a digital game from within a natural history museum even if provided with the necessary technology.

### Adult Focus Group

Thirteen museum staff members from the Geology, Education, and Exhibits departments participated in an adult focus group in December 2011. For the adult focus group, we were interested in how well the gameplay mimicked the experience of a paleontologist, how to mesh gameplay and an accurate depiction of the scientific process, the look and feel of the game, and suggestions for expansion and

improvement. These adult testers said the game concept was both engaging and educational. Players stated that the game activities and mechanics accurately mimicked scientific activities and presented the underlying concepts and facts in an appropriate manner for the intended audience. Most adults who participated were not avid gamers and suggested that an introductory tutorial would help to orient them to the game storyline and mechanics. These testers did not appear to recognize standard game design elements such as guiding a player through a space using lighting, and had a harder time navigating the game than did youth players. Although our conclusions are limited by a very small sample size and biased due to the source of the sample (all museum staff), adult and youth players favored different aspects of the game prototype. Adult players seemed to favor the graphics and accuracy of GoB, naming the Office, Notebook, and Reconstruction as their favorite parts of the GoB prototype. In contrast, youth players preferred the activities, naming Fossil Assembly and Sorting as the most engaging parts of the game.

### **Future Development**

As iterative development continues on GoB, the FMNH team will take a two-pronged approach: 1) refine single-player web-based gameplay and 2) explore and prototype collaborative and in-museum gameplay. A single-player non-museum game was the preferred product of the youth focus group, so it is important to continue developing this design. However, testing the feasibility of a multi-player non-museum game will also be a priority for future development. Given our ultimate goal of broad-scale usability at museums nationally, in-museum gameplay will be prototyped as well. FMNH expects in-museum development to include a new and different suite of focus groups, site visits to institutions around the country, and discussions with exhibits and paleontology staff.

### **Conclusion**

Science content and the scientific process are often inaccessible for youth. Youth often perceive science as a collection of obscure facts that are unrelated to their daily lives, and do not realize that science is a dynamic activity. At its most basic, science entails asking questions and making observations, two activities that people practice regularly, if unknowingly, in their daily and digital lives. When complete, the scientifically accurate GoB may provide a way for players to apply or improve these skills in context, making the scientific process 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, the scientific experience provided by GoB has the potential to provide youth players with a better understanding of paleontology and museum research.

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# Commercial Video Games as Preparation for Future Learning

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**Abstract:** To examine the learning benefits on traditional school content of recreational play of commercial games, 102 community-college participants were randomly assigned to play *Call of Duty 2*, *Civilization IV*, or no game at home for at least 15 hours over 5 weeks. All participants then took a short multiple-choice test about World War II history; heard a 20-minute lecture about World War II; and then took another multiple-choice test about World War II history. Results (using an intention-to-treat analysis) showed no differences on the pre-lecture test but a positive effect (Cohen's  $d = .27$ ) of gameplay on the post-lecture test, suggesting that recreational gameplay had prepared participants to learn from the lecture. These findings suggest a new role for games in learning contexts, in which the games—instead of carrying the educational load alone—provide compelling experiences that are coupled with the powerful explanatory structures of a formal curriculum.

## Introduction

In the field of digital game-based learning there has been much focus on the development of educational games—games designed specifically to teach. Attention has also been paid to commercial, off-the-shelf (COTS) games, but that work has focused mostly on the motivation, engagement, and community participation engendered by such games. To complement such work, in this paper I hope to demonstrate that recreational COTS gameplay can, under the right circumstances, lead to learning gains on even the traditional, fact-based curricular instruments criticized by many in the educational research community but used widely in schools today. By showing this learning benefit of COTS games, I hope to strengthen the argument for digital game-based learning more broadly.

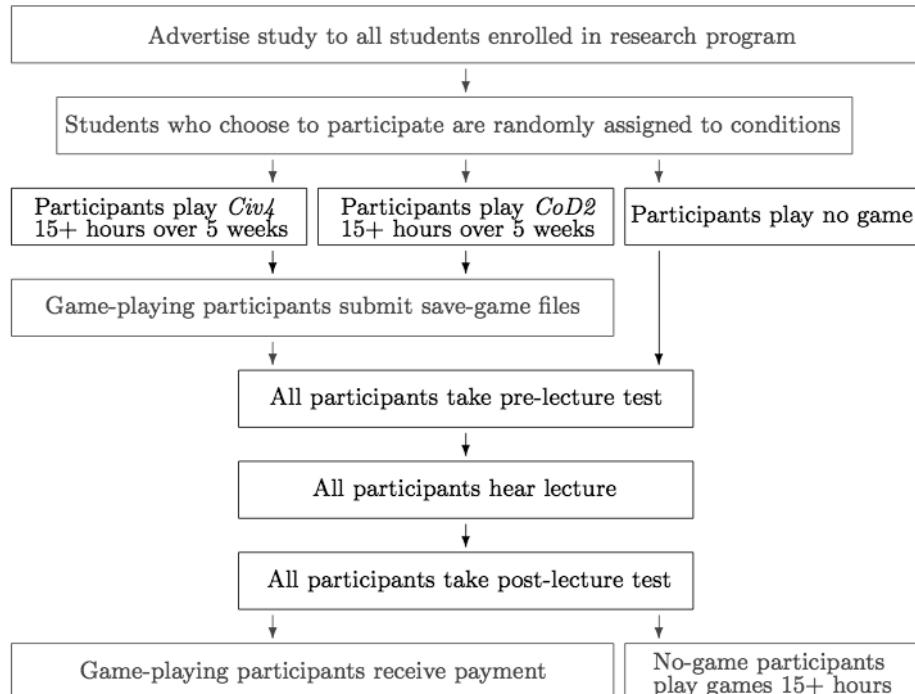
It is not surprising that there has been relatively little research demonstrating the benefits that might accrue on traditional fact-based tests from simply playing COTS games in one's leisure time, because there is no reason to expect that games created purely to entertain would produce learning benefits on school content that are measurable by traditional assessments. A novel assessment framework called Preparation for Future Learning (PFL), however, is designed specifically to measure immature forms of knowledge that traditional assessments miss. It does this by incorporating learning resources into the assessment process to determine what test takers' immature knowledge has prepared them to learn (Bransford & Schwartz, 1999).

In this study, I used the PFL framework to investigate whether being randomly assigned to receive and play one of two COTS games (*Call of Duty 2*,  $n = 34$ , or *Civilization IV*,  $n = 35$ ) at home over the course of five weeks would prepare community-college students to learn from a lecture about World War II compared to a control condition that received no game ( $n = 33$ ), as measured by performance on pre- and post-lecture multiple-choice tests. In a more qualitative vein, I also examined whether participants' gameplay experiences would influence their responses to open-ended questions about scenarios from World War II that were not mentioned in the lecture.

## Methods Design

The study was an experimental field trial with non-random selection of participants from a convenience sample but random assignment of participants to three conditions. Two of these conditions' participants were given one of two commercial video games, *Call of Duty 2* (*CoD2*) or *Civilization IV* (*Civ4*), which they were assigned to play at home for at least 15 hours over a period of five weeks; the third condition's participants were given no game and assigned no gameplay. After this five-week period, participants from all three conditions came to a room on their community-college campus, took a 16-item pretest about World War II history, watched a 20-minute video of a narrated-slideshow lecture about World War II history, and then took a 36-item posttest and a brief survey. After completion of the session, participants were given research credit, and participants in the condition that had not already received a game were given one and asked to play it for at least 15 hours over a five-week period. (Although the post-instructional gameplay of these control-condition participants was not of theoretical interest for this study, I did not want control participants to participate less fully because of being assigned to a condition that received neither a game nor the

opportunity for a gift card, so I explained in the initial information session that participants in all three conditions would receive games to play for compensation and that the only condition difference would be the timing of that gameplay.) All participants who completed sufficient gameplay (as determined by examination of save-game files) were e-mailed digital \$75 Amazon.com gift cards. Figure 1 details this design.



**Figure 1: Experimental design and procedure.**

## Participants

I recruited 119 participants and obtained usable data from 102(1), all of whom were students at a local community college who were enrolled in introductory social-science classes that required research participation for course credit. The final participant sample exhibited high diversity in ethnicity, nationality, socioeconomic status, and prior digital gameplay. Participants ranged in age from 16 to 42 years, with a median age of 20, and 66 of the 102 participants were female.

## Materials

Each participant was given a new, shrink-wrapped copy of either *CoD2* or *Civ4*, installable on the participant's personal computer (both Windows and Macintosh versions were available).

The lecture took the form of my narration of a 24-slide presentation that discussed the events of World War II while focusing on the two themes of *Nations* and *Battles*, which I hypothesized to be more relevant to the players of *Civ4* and *CoD2*, respectively. Although the lecture was written so that players of the two games would retain information from different parts of it, I never mentioned either game in the lecture.

The multiple-choice-tests, which were intended to look for benefits of recreational gameplay even on the most traditional, "schoolish" measures, comprised items from the National Assessment of Educational Progress (NAEP: National Center for Education Statistics, 2011), the California Standards Test (CST: California Department of Education, 2009a and 2009b), and a purpose-built test from a World-War-II study guide produced by the company SparkNotes (SparkNotes Editors, 2005), which also served as a primary source for the lecture.

I also administered a pre-experimental questionnaire and an exit survey to (a) screen out anyone who had played either game before, (b) collect demographic data, and (c) solicit feedback about game enjoyment and learning behaviors.

As another way to examine effects of gameplay on learning, I asked participants open-ended questions about two scenarios presented in the exit survey after the post-lecture test. The scenarios had not been mentioned in the lecture but were intended to build upon the lecture's two themes of *Nations* and *Battles*, respectively. In the *Nations* scenario, British ships fired on their French allies in 1940 off the coast of Algeria. In the *Battles* scenario, American soldiers scaled a cliff under heavy German fire to disable an artillery battery. After presenting each scenario, I asked participants what they would want to learn to better understand the scenario.

## Results

My primary analysis protocol was as follows. I first identified a set of variables that might predict performance on the pre- and post-lecture tests, as shown in Table 1.

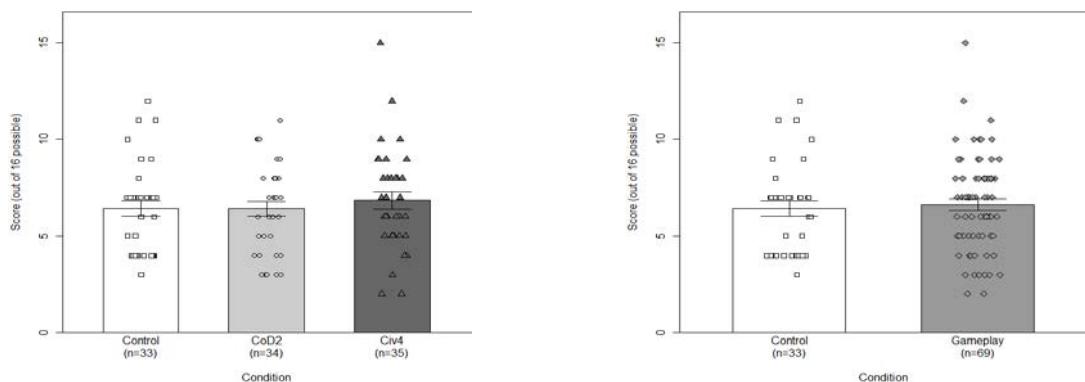
	<b>Control</b>	<b>CoD2</b>	<b>Civ4</b>
<b>Age in years</b> M (SD)	22.76 (6.77)	22.65 (6.84)	22.60 (5.94)
<b>English proficiency</b> (reading/speaking composite) M (SD)	3.17 (1.23)	3.53 (1.71)	3.31 (1.56)
<b>Game enjoyment</b> 1, 2, 3, 4, 5 (on Likert scale) M (SD) [if treated as continuous]	0, 0, 33, 0, 0 3 (0)	3, 5, 7, 11, 8 3.47 (1.26)	2, 6, 8, 15, 4 3.37 (1.09)
<b>Gender</b> Females, Males	21, 12	21, 13	24, 11
<b>Prior digital gameplay</b> Never, 1-2 times, 3-6 times, > 6 times	5, 4, 7, 17	6, 7, 3, 18	3, 2, 4, 26
<b>Prior social-studies interest</b> 1, 2, 3, 4, 5 (on Likert scale) M (SD) [if treated as continuous]	2, 1, 8, 13, 8 3.73 (1.07)	2, 3, 8, 15, 6 3.59 (1.08)	2, 4, 8, 11, 10 3.66 (1.19)
<b>Quarter</b> Winter, Spring, Autumn	17, 7, 9	17, 7, 10	13, 13, 9

**Table 1: Candidate predictor variables.**

Next, I constructed Analysis of Covariance (ANCOVA) models with the pre- and post-lecture-test scores as dependent variables and the variables listed in Table 1 as predictors, along with a gameplay-condition factor (because my primary interest for these analyses was the effect of gameplay rather than of each specific game, this two-level factor contrasts *CoD2* and *Civ4* participants with Control participants). For the post-lecture test, I also included pre-lecture-test score. My first step for each analysis was to test a model containing main effects of all predictors against a model that also contained all one-way interactions with the gameplay-condition factor, but in neither case did the marginal explanatory power of the interaction model reach statistical significance. Therefore, neither of the models discussed contains any interaction terms. Using the saturated main-effects model as a starting point, I then performed an all-possible-subsets model selection (2) to find the model with the highest  $R^2_{adj}$ , with the constraint that all predictors in models under consideration be at least marginally significant ( $p < .1$ ). I will present these “parsimonious” models below.

## Pre-lecture test

As shown in Figure 2, mean scores on the pre-lecture test were low for all three conditions.



**Figure 2: Pre-lecture-test scores by condition and gameplay.**

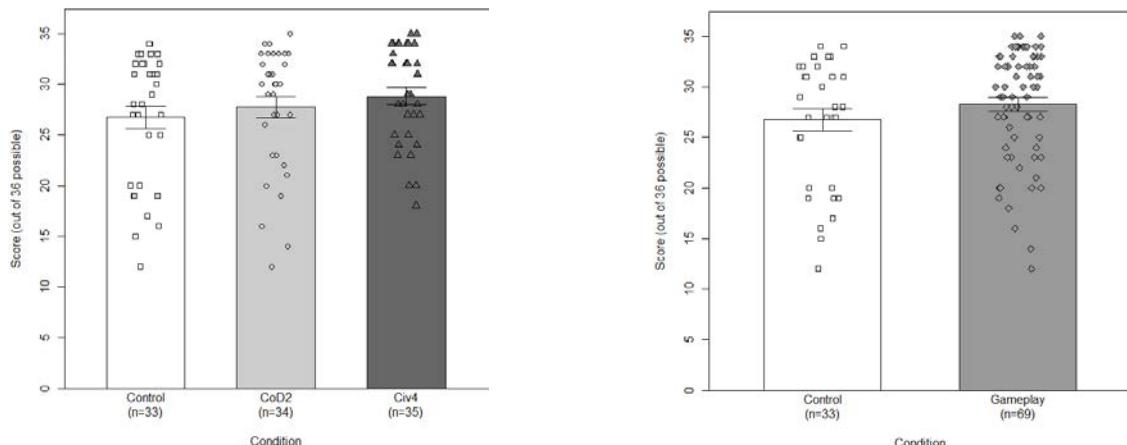
The test also had low reliability for this sample (Cronbach's  $\alpha = .43$ ), most likely because many participants were guessing on many of their responses, thus introducing random noise to the measurement. The sole predictor chosen by the all-possible-subsets selection procedure for the parsimonious ANCOVA model for pre-lecture-test scores was English proficiency, as shown in Table 2. Notably, gameplay condition was not predictive.

	<i>df</i>	<i>SS<sub>TypeIII</sub></i>	<i>F</i>	$\eta^2$	<i>p</i>
<b>English proficiency</b>	1	70.86	13.32	.12	.00042***
<b>Residuals</b>	100	532.16			
$R^2_{\text{adj}} = .11, F(1, 100) = 13.32, p = .00042$					

**Table 2: Pre-lecture test ANCOVA.**

### Post-lecture test

As shown in Figure 3, scores on the post-lecture test were much higher than on the pre-lecture test, indicating that participants in all conditions learned from the lecture. The test's reliability for this sample was also much higher than was the pre-lecture test's (Cronbach's  $\alpha = .86$ ). Mean scores in the gameplay conditions were slightly higher than in the control condition, suggesting a small benefit of gameplay (Cohen's  $d = .27$ ).



**Figure 3: Post-lecture-test scores by condition and gameplay.**

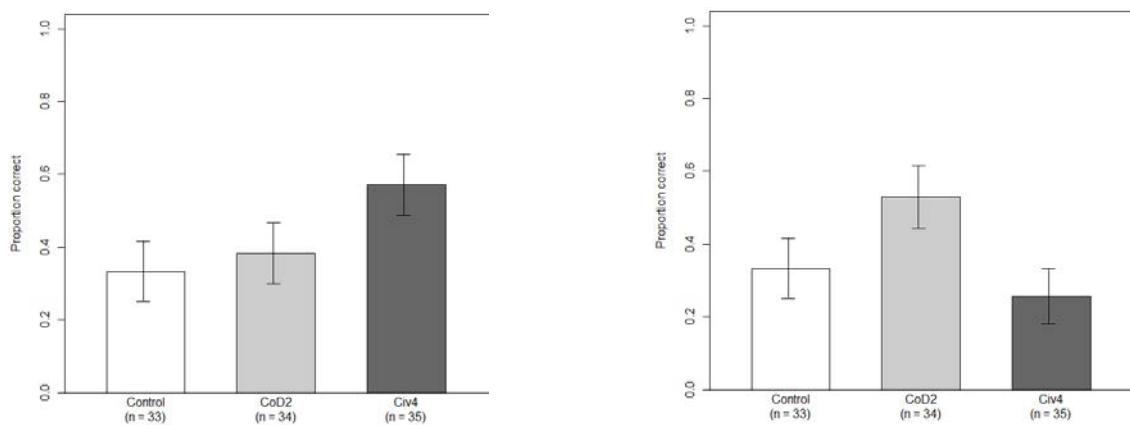
The all-possible-subsets selection procedure for the ANCOVA model with post-lecture-test score as dependent variable produced a model with seven predictors, as shown in Table 3. Notably, gameplay condition (denoted by the "Received a game" variable) was selected in this model, albeit with a small effect size ( $\eta^2 = .026$ ). Age, English proficiency, game enjoyment, pre-lecture-test score, and prior social-studies interest were also positively associated with post-lecture-test score. (Quarter of participation was marginally significant, reflecting cohort or seasonality effects that are not of theoretical interest but that contribute construct-irrelevant variance.)

	<i>df</i>	<i>SS<sub>TypeIII</sub></i>	<i>F</i>	$\eta^2$	<i>p</i>
<b>Age</b>	1	123.55	5.63	.036	.020*
<b>English proficiency</b>	1	70.86	13.32	.12	.00042***
<b>Game enjoyment</b>	4	239.07	2.72	.069	.035*
<b>Pre-lecture-test score</b>	1	145.08	6.60	.042	.012*
<b>Prior social-studies interest</b>	4	334.12	3.80	.096	.035*
<b>Quarter</b>	2	125.40	2.85	.036	.063.
<b>Received a game</b>	1	88.97	4.05	.026	.047*
<b>Residuals</b>	87	1910.95			
$R^2_{\text{adj}} = .36, F(14, 87) = 5.06, p < .0001$					

**Table 3: Post-lecture test ANCOVA.**

## Open-ended questions

Because I had intended the *Nations* theme to resonate more with Civ4 players and the *Battles* theme to resonate more with CoD2 participants, I predicted that the *Nations* scenario would elicit more responses focused on *Nations* themes from Civ4 players, and likewise the *Battles* scenario would elicit more *Battles*-focused responses from CoD2 participants. Figure 4 shows results by condition for the two scenarios. In these graphs, correctness was determined by whether the questions participants asked about the scenario reflected a focus on the appropriate theme for that scenario: e.g., for the *Nations* scenario, a question about whether the French ships being fired upon were controlled by Germany would be scored as reflecting a *Nations* focus, whereas a question about whether the French commanders had insulted the British commanders would not. The error bars in each graph represent the 68% confidence intervals for the proportions (corresponding to roughly +/- 1 SD, assuming normality).



**Figure 4: Open-ended responses for *Nations* (left) and *Battles* (right) scenarios.**

Fisher's exact test of proportions for the *Nations* scenario was marginally significant,  $p = .058$ ; for the *Battles* scenario, the test was significant,  $p = .030$ .

## Discussion

Taken together, the results of this study support the claim that playing enjoyable video games at home can help both male and female students learn in school, if the formal instruction leverages the students' gameplay experiences. (The strong predictive effect of prior social-studies interest for the post-lecture test shows the importance of also leveraging students' interests.) The multiple-choice-test results showed only a small effect, but this study was intentionally conservative with respect to its design (randomized field trial using an intention-to-treat analysis, both considered "gold standard" methodologies for causal inference), its intervention (recreational gameplay of commercial games that were not designed to teach school content), its outcome (learning gains compared to control participants on traditional history content delivered via direct instruction), and its measurements (traditional multiple-choice tests whose items were taken from existing standardized tests rather than developed *ad hoc*). The open-ended-question results underscore the notion that more creative measures show stronger positive effects of recreational gameplay. They also demonstrate that different games will offer different types of experiences that prepare players preferentially for different topics of formal instruction and that these gameplay experiences can improve not only retention of facts presented by direct instruction but also students' choices about what to learn.

I propose two main conclusions from this study. From a theoretical perspective, there is a benefit to simply having demonstrated that the learning that occurs in naturalistic gameplay can be detected with the PFL framework. Showing that fruit can be plucked from this region of the digital-game-based-learning space (i.e., involving pre-instructional gameplay paired with a formal curriculum) strengthens the basic argument for digital game-based learning.

From a more pragmatic perspective, demonstrating that informal COTS gameplay can lead to learning gains in schoolish contexts suggests a specific policy prescription for educators: to consider the games their students are already playing not as competition for precious time that could be spent studying or doing homework but as rich source material for use in engaging curricula that could tie the compelling experiences found in the games with the powerful explanatory structures found in the standard curriculum. A concomitant policy prescription for commercial-game developers is that their games could contribute to efforts in digital game-based learning without having entire curricular units crammed into them—developers need only be thoughtful about how the experiences provided in their games might be tweaked this way or that to better serve as foundations upon which educators might build. This lowered bar for participation in the digital-game-based-learning space might encourage more commercial developers to lend their considerable strengths to the process of bringing classrooms into the 21st-century.

## Endnotes

- (1) The 16 participants who dropped out did so because either they were no longer enrolled in a relevant social-science class or because they had technical or time-management problems preventing them from completing the at-home gameplay. The 17th lost participant was removed for cheating on the post-lecture test.
- (2) An all-possible-subsets selection procedure examines every model that could possibly be constructed using a set of predictor variables to find the “best” model according to some pre-defined criterion.

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# **“Oops, I Learned Something”: Teaching Via Game Mechanics**

Bryan Cash, Francisco Souki, Schell Games

**Abstract:** This paper describes, with extensive examples, the process by which video game mechanics can be designed to further an educational message. To do so, we study the case of a video game that is being developed in tandem by a traditional video game studio and nonprofit organizations. 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. We present a list of the different game systems that were designed to carry forward the messaging while retaining their fun factor—mainly Combat, Missions, Conditions, and Multiplayer. A mechanically solid game is built in which the messaging is embedded in metaphors and supported by the game’s story and mechanics, pushing forward the notion of Incidental Learning.

## **Introduction**

In Fall 2011, Schell Games began work, in collaboration with the BEST Foundation and Drug Strategies, on 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 begins with a description of the game’s educational goals and its unique constraints. This is followed by a look into the process of defining the game’s educational objectives and the choice of game mechanics to support them. Following this, an explanation of how the different game mechanics in the game work together to push the educational message forward is presented. We conclude with an overview of how each educational objective is addressed by the game’s design.

It is important to note that the game is currently in the final stages of development and not yet released. All names and features described are not final and may not represent with exactitude the final product.

## **Defining the game**

The first step toward the game’s development addressed the definition of the platform and target audience. The game would be developed for the iPhone, iPad, 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 would 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.

## **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.

## **Methodology**

Instead of approaching the messaging explicitly, the game 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 such 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 that 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.

## Defining the game goals

The process of defining the goals for the game led to the realization that first and foremost, the game needed to be fun. In contrast with other educational projects in the space in which the educational factor seems dominant, this particular project would focus on creating an entertaining product that taught the players a valuable message, rather than an educational game that struggled to be fun.

As such, the main 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.

## Willpower vs. Control

During the development of the game, several core concepts were proposed to bear the weight of the educational theming. 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.

## Game story

The story of the game takes place in current times, and places the player as a human who aids a group of Mice in the fight against the mysterious Controllers. These beings have infiltrated Mouse Burrows all over the world and have inadvertently unleashed the full potential of Mousekind: Mice in the game can walk upright and speak, and have a range of emotions as wide as any human's. Mice feel drawn to them, for they provide unmeasurable power.



**Figure 1: Game Characters – from left to right: Advisor, Leader, Captain, Tradition Keeper**

The particular group of Mice that the player is roped in to aid, however, has realized that Controllers are harmful for Mousekind. They enlist the player's help and place them in command of a small group of Mice in their quest to confront a group of Controllers who are threatening their immediate area.

The characters pictured in Figure 1 will accompany the player throughout the whole game. These characters are not portrayed as flawless leaders but rather as flawed individuals that are leading with their own insecurities. The Advisor is curious and sometimes reckless, the Leader is insecure and comes from a family where too much was expected of him, the Captain is strong but doubts her abilities and the Tradition Keeper is prone to seeing the world in terms of black and white. The player will see how these mice work through their own problems together throughout the game.

As the game progresses, the player's group encounters other Mouse groups that have given in to the Controllers for different reasons. The player's group helps these Mice and recruits those who wish to help in their fight. As they encounter the different groups, the different supporting characters that accompany the player will unravel their own problems and insecurities and be forced to deal with them and overcome them with the player's help.

## **Mechanics addressing messaging**

The game's goals were drafted in a way that stressed the importance of creating a fun product, and the development team was encouraged to build game systems that embraced the messaging, rather than having them meet strict curriculum goals.

The result of this process was the consummation of the game systems, which are described in the following sections, along with a look into the way in which they further the game's message.

The decision to implement these systems was not coincidental, nor did we get them right at the first, second, or even third try. Combat, as the main system, was chosen to carry the weight of the metaphors since it is the activity in which players will engage the majority of the time. Missions serve the purpose of communicating the game's story in a way that is not too text-heavy and which places players at the core of the action. Conditions were included as a means to communicate the risks and consequences that are related to substance abuse. The Multiplayer aspect was implemented with the goal of creating a positive peer group for the player.

## **Combat**

Combat is the main interaction in the game. It is the way that players progress through the story and the activity in which players engage the vast majority of the time. As such, great care was put into developing a solid metaphor for combat to rest upon.

Combat in the game is meant to represent tense situations in which our target audience might be pressured into giving into temptation. As mentioned before, the main goal of the game is not to equate substances to evil, but rather to provide our players with the tools to recognize and navigate situations in which they might be pressured, coaxed or convinced to do something that they are not quite sure they want to do. After looking at these situations, we recognized elements that liken it to combat: they are battles of sorts in which both parties are fighting over control of the situation.

As such, combat was designed as a metaphor for these situations. When one of the mice controlled by the player encounters an opponent, they hold a conversation in two levels: first and foremost, they scuffle like the mice they are. But, since these mice have recently found the ability to also communicate with words, they also talk as they scuffle.

All of this is framed in real-time, menu-based RPG-style combat, similar to what would be found in traditional RPGs. During their turn, players must quickly choose what move, or Power, their mouse will execute next. Each move weakens the enemy or strengthens the player's mouse.

## **Pressure**

The most distinctive element of combat is the Pressure system. Pressure is displayed to the player via a central gauge with three main areas—at any given time, the combat can have one of three pressure levels: low, medium, or high. This represents the different types of situations in which the players might see themselves involved, as not all pressure situations will be aggressive, but rather they could be persuasive or even appear to be logical. Pressure affects most of the actions taken by

players in combat, and they will be expected to learn how to successfully navigate the different pressure situations.



**Figure 2: Concept art for the Pressure Gauge (art not final)**

Each Power available to the player during combat has an inherent Pressure level, meaning that it will be the most effective if used when the Pressure in combat is at that level. Additionally, characters cannot bring all known Powers into combat but must rather choose what combination of Powers to bring. As such, a character will not be prepared to navigate every kind of situation but rather will have to learn how to keep a situation at a pressure level at which they're most comfortable.

All in all, each character the player can take into battle and each enemy they face in the game will thrive at a specific level of pressure. Adapted to the game's lore: warriors are more forceful and thrive at high pressure; mages are more logical and like mid-pressure situations; and rogues are more subtle and casual, and look for low pressure situations.

In general, the Pressure system aims to communicate where pressure comes from, and how to deal with pressure.

### **Dialogue and response tables**

The mice don't just talk randomly as they fight—they hold a conversation. The game is designed such that each combat is kicked off with an opening remark from the bad guy, which is displayed at the top of the screen. It will then be the player's turn to choose a move to attack the bad guy—when this happens, the system will look up an appropriate response to what the bad guy initially said and, depending on the pressure level of the move, will pair the response to the attack and display it.

As this goes on repeatedly, the mice and the bad guy will appear to be having a conversation as they scuffle. Through all of this, the player will be learning of viable ways to respond to potential situations with which they might not be comfortable dealing normally. However, the nature of the text will change depending on the different attacks that are performed.

An example of this is as follows:

- Bad guy attacks, saying: "It feels so good. Think of all the fun you could be having"
- Depending on the Power the player chooses, the mice could say:
  - For a Low Pressure Power: "If it's so much fun, why are you trying so hard?"
  - For a Medium Pressure Power: "I don't think I need you to enjoy myself".
  - For a High Pressure Power: "Do I look like I need you?"

We call these banks of responses "Response Tables", which are crafted to cover all possible types of responses to the bad guys' remarks. The different types of responses come from the different pressure levels of the Powers that the player might execute. A Low Pressure Power, for example, is paired with a Low Pressure line of dialogue - and the same is true for other Pressure levels.



**Figure 2: Early concept art for game interactions (art not final)**

A strong point of the game is the vast variety of attack phrases and possible responses. This ensures that combat doesn't feel overly repetitive while at the same time providing for enough repetition for the players to become familiarized with the phrases. More importantly, this text appears to be secondary to combat and the player does not, seemingly, need to read it at all to be successful in the game. However, it is a head fake since the text is featured prominently on the screen and is visually engaging.

The main strategies that dialogue in combat aims to teach are:

- Saying “no”.
- Giving a reason.
- Giving an alternative.
- Standing up to pressure.
- Stress management.
- Self motivation.

## Missions and themes

Combat in the game is encased in Missions, meaning that players get to the different combats by sending their Mice on Missions. Each of these Missions is comprised of sequential Stages and aims to tell a contained story that moves the general story forward. Missions are straightforward: the player sends a Mouse on a Mission, waits for the Mouse to reach its destination and then jumps into the action by helping the Mouse confront the bad guys it encounters.

As the player progresses through the story, they will unlock new locations for their mice to go on Missions. Each of these locations represents a real world setting. The reason the player's mice explore these locations is because each of them is inhabited by a group of mice that, in one way or another, have been affected by the Controllers.

Each group of mice, and consequently each game location, is presented within a theme. These themes revolve around the central concept of Control as described earlier, and are presented as follows:

- In the Park, the core emotion is Excitement.
  1. Excitement without Control leads to Excess.
  2. The player meets a mouse group that sought excitement, taking bigger and bigger risks until they went too far.
- In a Human House, the core emotion is Discipline.
  1. Discipline without Control leads to Intolerance
  2. The player meets a group of mice who, on their quest to distance themselves as much as possible from the Controllers, languished into hermitage. These mice see everything in terms of black and white, and persecute anyone they see as flawed.
- In the City, the core emotion is Rebellion.
  1. Rebellion without Control leads to Chaos.

- 2. The player meets a group of mice who were champions of brave and new ideas. They were corrupted by the Controllers into rejecting everything around them in service of making the world pay for the slights done to them.
- In the School, the core emotion is Community.
  - 1. Community without Control leads to Conformity.
  - 2. The player meets a group of mice who suffered from loneliness and loss. All they wanted was to fit in, so they changed so much that they ultimately lost their sense of identity.
- In the Suburbs, the core emotion is Confidence.
  - 1. Confidence without Control leads to Arrogance.
  - 2. The player meets the most powerful and proud mice. The Mouse Tribe became arrogant, picking on other mice who they saw as being beneath them.

## **Recruiting new Mice**

As the player moves along the story and explores the different locations, they will recruit new mice to join their cause. These new mice will be members of the different groups they meet along the way. In this manner, the recruiting mechanic supports the message of helping those in need and stresses the fact that these mice are not beyond help. Rather, the player incorporates them to their group and sends them on missions just like every other mouse in the group. These mice become part of the family.

## **Blind Missions**

Not all missions include a combat section. Rather, some Missions will require the player to send their Mice to a location where they will need to fend for themselves. The player will need to choose the Mouse that they feel fits the job better and trust that they will be able to do well on their own. This is meant for players to send their Mice into the unknown, trusting that they will do the right thing.

## **Conditions**

The most literal translation of messaging into game mechanics, Conditions represent long term effects that affect mice. Metaphorically, Conditions are meant to represent the Mice being under the influence of a specific substance or being put through a difficult situation. In terms of game mechanics, mice can obtain conditions by failing at a combat or as a result of a blind mission. Additionally, some new recruits might join the player's group already with a condition that is a result of their troubled past.

In the game, Conditions are always curable. No Mouse is ever lost totally to a Condition. This is meant to represent the fact that any person who has a Condition can be helped. It's not a matter of winning or losing, but rather one of working through problems with the help of others. Examples of conditions in the game include: ashamed, alone, injured, dazed, and insecure.

## **Multiplayer**

The multiplayer element in the game is light, but goes a long way in letting the player know that they are not alone in their fight. Players are able to select a leader for their group of Mice, and enlist their friends' leaders' help on missions. This way, it becomes evident that their friends are also battling the same forces and they can even get a notion of how far into the struggle they are by comparing against a friend's level. The goal is to create a positive peer group for the player, to reinforce the notion that there are people out there who are working toward the same goals.

## **Meeting the goals**

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 theming.

In the periphery, Missions address bit-by-bit learning by equating it to sporadic gameplay. Conditions help drive home the fact that there exist 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.

## Conclusion

The aim of this paper is to show a practical example of how game mechanics can be used in a game to help support a core educational message. By exposing the development process and thoughts behind this game, the hope is that other game developers might borrow from the methodology taken in this project and apply it to the extent that they see fit in their own games.

By providing several examples of how the mechanics of the game propel the messaging while retaining their value as fun game mechanics, the aim is to prove that it is possible to create a dialog between the game's mechanics and its educational messaging. Ultimately, the messaging should drive the design to the same extent that the design drives the messaging.

The hope is that the fact that the development team for the project is comprised of both a traditional game development studio and two nonprofit organizations serve as inspiration for other organizations and studios to seek similar partnerships.

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# Gaming the System: Manifesting Affinity and Resistance Through the Visual Play

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**Abstract:** We argue that Anonymous aspires to a condition of aesthetics without art, politics without the polis, and praxis without theory. It intervenes on the political, economic, and social domains and does so by remixing a coherent and evolving *visual affinity space*, often articulated through the imagery of video games. Put differently, the iconography of Anonymous does not seek to foster communities, but rather instantiate constantly shifting markers of affinity and participation through a particular *visual literacy*. We argue Anonymous provides a new mode of political self-portraiture, one in which there is a staging of the self that is, perhaps as any self-portrait might be, an aspirational image.

## Introduction

Anonymous is a leaderless, structureless, charterless internet-based grouping that has engaged in a string of disruptive demonstrations and Internet hacking attacks on organizations ranging from the Church of Scientology to major financial institutions. The group, if we can call it that, is noted for its theatricality, its irreverent sense of humor and its love of anarchic Internet culture, values made explicit here in this image taken in 2010 at an anti-scientology demonstration. The sign, as we see, reads “Don’t worry, we’re from the Internet” (Figure 1). However, this same photograph points to the emergence of a recognizable iconography that has proliferated in “real world” global protests. This evolving iconography is born out of the circulation of images drawn from sources as diverse as Hollywood films, Internet memes, or computer games. Through its engagement with this new iconography, Anonymous seeks to intervene in new ways on political, economic, and social domains. This iconography is the product of a new visual literacy, a new visual grammar of design and meaning making, (Kress, 2006) around which affinities, identities, and new knowledgeable practices gather dynamically. Put differently, we argue that the iconography of Anonymous does not simply foster the development of a static subcultural community, but rather instantiate constantly shifting markers of affinity, identity, and participation through the demonstration of that visual literacy.



**Figure 3: A physical Anonymous protest**

Since the New London Group manifesto (Cope et al., 2006), an increasing number of scholars have adopted the view that the “reading” and “writing” of new multimodal and multimedia representational systems constitute new forms of literacy. This scholarship in “multiliteracies” has begun to investigate

how representational forms from images (Kress, 2006) to computer game play (Squire, 2010) can be understood as literacies. Social groups can use these symbolic systems—sets of images, videos, and interactive media—to produce, share, and decode meanings. Recent work on affinity spaces has characterized these semiotic systems, these multiliteracy domains, as the glue that holds otherwise anonymous online social spaces together (Gee, 2006). What these studies reveal is that in online spaces these unique literacy domains and symbol systems become the primary means through which participants express their identity and affiliation with a given social group. Anonymous, in particular, utilizes a very distinctive genre of images to express identification and affiliation, chief among which are the specific images of the Guy Fawkes mask and the empty suit.

### **Political Protest, Performance and Image Production**

The extent to which the Guy Fawkes mask had become a symbol of disruption and protest was made clear in legal actions taken by the Spanish Government against Anonymous. On June 10, 2011, the Spanish National Police announced their triumphant arrest of three alleged leaders of Anonymous for hacking attacks against the cyberinfrastructure of Spain's Central Electoral Board, Spanish banks BBVA and Bankia, and the Sony Playstation Network among other institutions. Spanish police trumpeted the arrests in a large press conference (Figure 2), claiming that they had created a vacuum by unmasking and apprehending leaders in the worldwide Anonymous organization. As their primary evidence against the accused, police proudly presented Guy Fawkes masks that they had seized from the suspects' apartments, alongside images of IRC logs, digital recordings of the perpetrators' online chat communications.



**Figure 4: Spanish national police trumpet Anonymous arrests**

The Spanish national police's claims to have arrested the leaders of Anonymous proved dubious. On the same day as the press conference, anonops, a self-declared online press office for Anonymous, published an image of a red V with the caption "expect US", adopting the iconography of the graphic novel and film V for Vendetta. The following day, a large-scale distributed denial of service (DDOS) attack, called "#OpPolicia" by Anonymous, was launched against the Spanish government, shutting down the official national police site for several hours. In the weeks following this incident, cyberattacks in Spain continued to grow in number rather than dissipate. Retaliations against the arrests knocked out the websites of Spanish banks and telecommunications firms, while a number of video polemics on sites like YouTube denounced the corruption of the Spanish government, financial system, and law enforcement. Around the time as this press release, the following image was posted on several websites. Using the press conference photo, the image was manipulated (Figure 3), the officer's faces crudely removed and switched with the masks they originally held in hand. They were widely circulated on Internet blogs and discussion sites as humorous evidence of the police's inability to understand how Anonymous operates and how swiftly this headless entity could wreak its vengeance on official bodies.



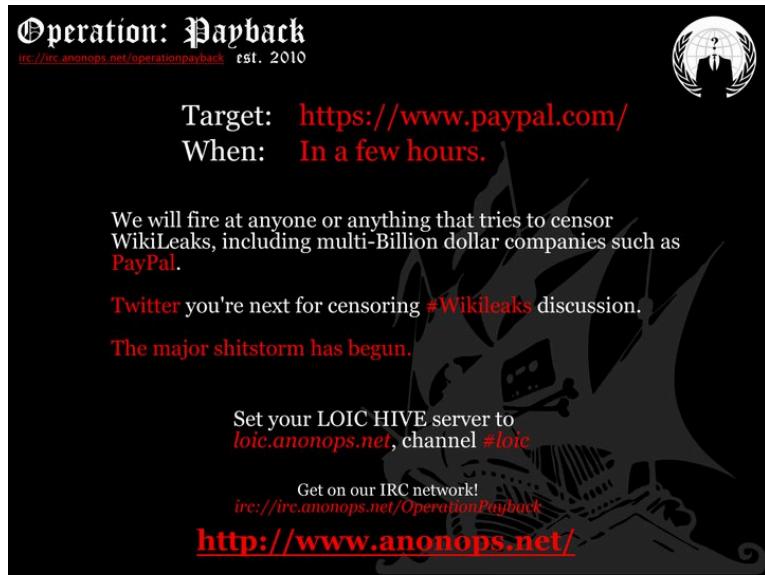
**Figure 5: Police press conference images manipulated**

### Gaming and the Visual Literacy of the Paypal Raid

Anonymous corrals a set of visual representations as a means gather up potential participants to constitute a new force to disturb the impassive surface of the status quo. Using often darkly humorous image has been key to the efficacy of Anonymous actions. In the absence of organization, membership or even community, viscerally resonant images mediate political praxis. These images are distributively authored by Anonymous to incite protest in the form of hacking, doxing, and pranking. But perhaps more significantly, Anonymous mobilizes this visual language in order to promote the use of participatory digital tools in political protest.

It should be noted that the manipulated image was released independently of the Anonops press release, that the identity of the author or authors of images or statements cannot be determined. And it is also notable that its production required little more than the most basic grasp of a program like Photoshop, or better yet Gimp, the open source image editor. This is not the product of several hours of considered, meticulous work but, rather was hastily executed in order to circulate the altered image as quickly as possible as a comic response. Timing's everything in a joke, and the humor of this image was immediately recognized. It was posted and reposted in blogs, message boards, and even Internet news sites within hours of the retaliatory hacks. The efficacy of playful imagery, the importance of engaging with the potential participant through humor is absolutely central role to Anonymous actions. In the absence of organization, membership, or even community, images mediate political praxis. Their "operations" are imagined, advertised, and coordinated through images, many of which use of simple graphic formats that can be easily rescaled and reworked without loss of resolution. Anonymous affiliated message boards offer advice about how best to manipulate images, often provide templates to facilitate the hijacking of existing genres of images like motivational or movie posters. These images often tap into fantasies of battling evil readily found in graphic novels and Hollywood action flicks.

What emerges is an anarchic, distributed and participatory pedagogy that teaches potential participants about the tools at their disposal. It does not end, however, with the production of what amount to propaganda posters. Far from it. The posters (Figure 4) are as instructional as they are promotional, and they often include crucial information to guide would-be participants in Anonymous to web sites or chat channels to learn the basics of hacking. The participatory and disruptive tools that Anonymous develops and distributes often give even novice computer users the ability to cause disorder and turbulence to Internet infrastructure. And just as the visual media of Anonymous tap into the heroic imagery of popular fiction, its tools for political action often leverage the embodied practice of playing a multiplayer computer game, as we see with this image derived from a *Team Fortress 2* poster (Figure 5).



**Figure 6: Instructional image for digital Anonymous protest**

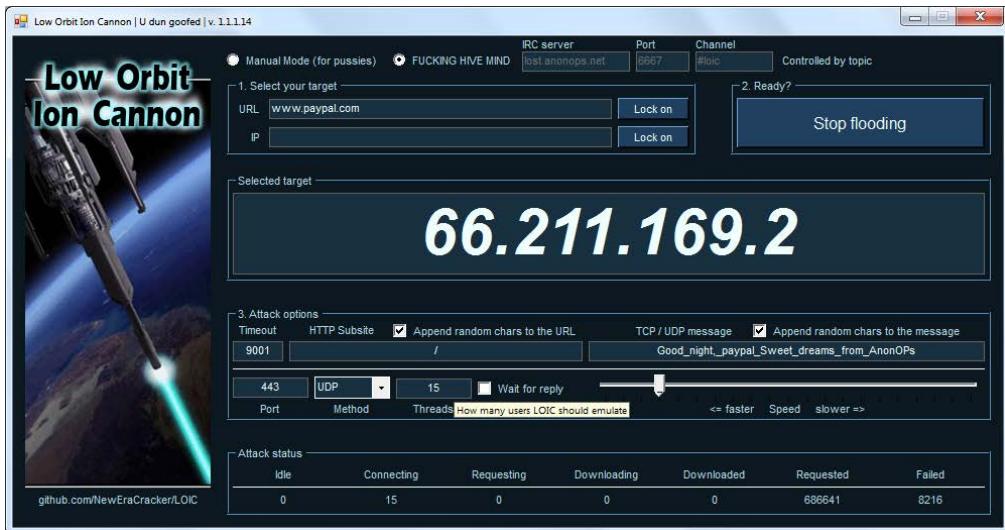


**Figure 7: Operation payback promotional image**

Take for example the case of Anonymous' Operation Payback, also called Operation Avenge Assange. In early December 2010, major financial corporations like Paypal, Mastercard, Visa, Bank of America, and PostFinance began what was tantamount to a financial blockade of the whistleblower organization WikiLeaks. In the first week of December, these companies, one by one, announced that they would stop processing financial transactions involving WikiLeaks, cutting off the non-profits foundations ability to accept donations that were its major source of funding. Outraged at what they called an attempt by major corporations to limit freedom of speech, Anonymous affiliates began circulating calls for action. On December the 8<sup>th</sup>, thousands of Internet users participated in an Anonymous-led distributed-denial-of-service attack (DDOS), flooding the servers of Visa and Mastercard, knocking their websites offline and slowing their payment systems.

These attacks employed Anonymous-created software called the Low Orbit Ion Cannon (Figure X6), which enabled the coordination of large numbers of users' computers in a distributed-denial-of-service, or DDOS, hacking attack. A DDOS attack is an attempt to make an Internet-based site or

resource unavailable to computer users by preventing it from functioning properly. In most cases it involves pools of networked computers inundating a targeted site with false communications data protocol requests. As a rough metaphor you might imagine hundreds of people simultaneously calling your phone for hours or days at a time, making the phone line register as busy and preventing anyone who actually wants to call you from getting in touch with you. It has been argued that the distributed denial of service attack can be the digital equivalent of civil disobedience, an act distributed mass political defiance, a denial of the extant digital order. LOIC software made the steps required to have a computer voluntarily participate in a DDOS attack as easy as a click of a button in a computer game. The Anonymous poster with the caption “Low Orbit Ion Cannon: When Harpoons, Airstrikes, and Nukes Fail” hyperbolically announces the grand ambition of this tool, tongue in cheek. The interface design, and even the name of the software, was borrowed from the interfaces of computer games like *Command and Conquer* 3. The fire button reads “Imma Chargin Mah Lazer,” a reference to a popular meme from the anime *Dragonball Z*. This software was designed so that the user need not have a full grasp that his computer would be used to send out large amounts User Datagram Protocol (UDP) echo requests to certain Internet Protocol addresses in an effort to overload a server’s bandwidth. Instead it adopted the metaphor of a cannon in a video game, “shooting” projectiles at its target, participatory political action at the push of a button. And in case clicking the button was too difficult for some users, or if the interface was too confusing for the novice, Anonymous distributed instruction manuals detailing what exactly to how to engage with the interface (Figure 7).



**Figure 8: Low Orbit Ion Cannon (LOIC) Interface**

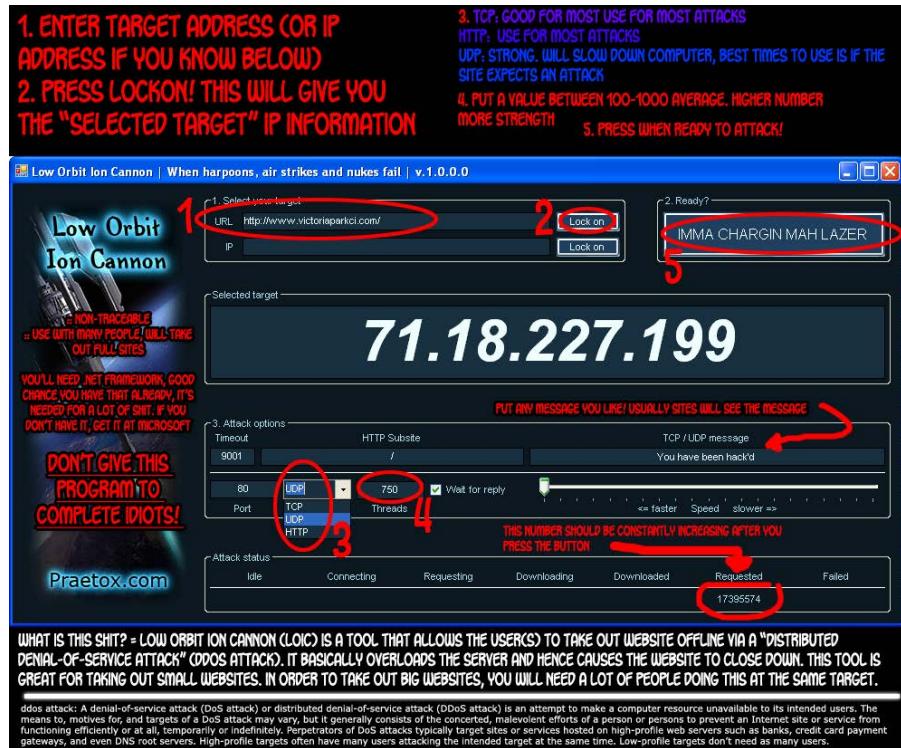


Figure 9: Step by step instructions for LOIC operation

And Anonymous' DDOS attack was quite different from the typical cyberattack in that it was voluntary. Characteristically DDOS attacks occur when hackers use a master computer to command botnets to attack a targeted server. Botnets are large groups of computers, often at large corporations or educational institutions that have been hijacked using malicious software. In the case of the attacks on Visa, Mastercard, and Paypal, however, Anonymous did not rely upon botnets or hacked computers at all. Instead, a new, customized version of the Low Orbit Ion Cannon software allowed users to link their computers together voluntarily, via Internet Relay Chat, in a "Hive Mind" mode that automatically coordinated attacks on the targeted Internet service. Some commentators remarked that it was the first instance of online civil disobedience, the digital equivalent of linking arms and sitting down in a doorway. These hacking tools distributed by Anonymous enabled anyone with a computer to participate in the disruption of social power structures, as they are articulated in digital space, through a kind of irreverent play. As serious as the consequences, as serious as the intent, the tools developed and the visual materials imagine their actions as part of a game, played with real life consequences (Figure 8). In important ways, these actions emerge as much out of a sense of collective injustice that provokes a series of actions. However serious the consequences, the design of the plot, the promotion and staging of the action, participation takes place in part for the laughs, or to take an internet neologism for laughing out loud, they're doing it for the Lulz.



**Figure 10: LOIC promotional imagery**

We bring attention to this particular tool, and to the visual promotional materials associated with it in part to show how elaborately Anonymous stages its actions. It takes the prankster impulse and transforms it through relatively simple technologies and software for use in projects of distributed digital disruption. Such pranks require technological masks, in this case, proxies to hide the identity of participants. But masking, more generally, plays a central role in Anonymous' activities more generally. In actual demonstrations the use of masks and wearing the suit enables role-playing, and the establishment of a peculiar kind of political theater.

### The Mask & The Mob: Imagery as affinity space

We'd like to argue that the use of the mask and the headless suit constitute props in a staging of self. We described this at the start of our lecture as modes of political self-portraiture.

The headless suit and the Guy Fawkes mask should be understood as part of what has come to be a shared marker of Anonymous whose efficacy is predicated on its use. Anyone can use these to become Anonymous. And as we pointed to at the start of the paper this is a transnational phenomenon. Anonymous, or at least individuals swathed in its costumes, have appeared in protests around the world. In the wake of the arrest of the Spanish youth allegedly perpetrating Anonymous attacks, demonstrations have taken hold of that country in the intervening months. In preparation for a call to action in October this year, Guy Fawkes masks quickly sold out.

We would like to close with this image of these young men dressed up in suits and ties, canes, and pinky rings, and the Guy Fawkes mask (Figure 1). The suits are cobbled together from stuff from the back of these young men's closets, suits they are probably not used to wearing on a regular basis, rumpled shirts not quite ironed out, collars hardly starched and their ties tied in knots unknown to the Windsors, half or full. But they wear the suit nonetheless to emulate the image of Anonymous as an entity comprised of many, whose identities cannot be wrest apart, whose participation in actions dissolve into thin air once the mask and costumes are removed. In this masquerade, protest and demonstration lay the stage for playing the part of the super hero, in the online DDOS attacks, a vigilante army battling corporate evil.

As we have argued over the course of this paper, Anonymous provides a new mode of political self-portraiture, one in which there is a staging of the self that is, perhaps as any self-portrait might be, an aspirational image. What we find in this photograph (Figure 1) is a group of young men emulating the images of the entity Anonymous online, responding to calls made on its behalf, promoted through posters anonymous individuals made, learning tactics this distributed entity what has come to teach.

### Conclusion

The iconography of Anonymous results from the nexus of a number of literacy practices, and represents a central means by which participants express their identification with the collective, and seek to garner the participation of others. These literacy practices are expressed in the production of

original digital images, the development of tools for disruptive protest, the appropriation of visual video game interfaces, and the remixing of imagery from popular media. These images result from the confluence of a number of different sociotechnical networks, as they circulate, frequently altered and detoured, from Hollywood films and major studio video games to image boards, chat channels, weblogs, and message boards (see Latour, 1987). The iconography itself is the result of the assemblage of a number of different texts, images, practices and discourses by participants in Anonymous. The software tools, design practices and aesthetic knowledge needed to undertake this remixing and reassemblage are provided in Anonymous-affiliating websites and forums, and taught in the group's chat channels.

The context in which the iconography is generated and distributed should not, however, overshadow the powerful response it engenders. The aesthetic quality of this imagery, and the way it calls forth potent feelings and actions, should not be lost in a discussion of the mechanisms of production and distribution (Leander & Frank, 2006). The aspirational imagery of Anonymous serves as a mass call to political action, one that seems to have very substantial resonance with those who respond. Research on the new literacies—on games, on online writing, on multimodality, on media production—often seems to ignore the way in which aesthetics are integral to the representational forms they investigate. Though the excitement this imagery provokes is undoubtedly bound up in its unique modes of production, its power lies in its affective capacity to engender a visceral and excited feeling of involvement and action, for better or worse. Anonymous reminds those studying digital literacies would do well to remember that feeling can be tied closely to meaning (see Lemke, 2010).

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# Triangulating Learning in Board Games: Computational Thinking at Multiple Scales of Analysis

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**Abstract:** In this paper, we delve into the connections between multiple methods for investigating game-based learning. We focus on three, connected analyses related to a single case (uncovering computational thinking in the play of the collaborative strategic board game *Pandemic*). We describe an approach for connecting *content analysis*, *learning analytics*, and *d/Discourse analysis* into a framework that both meaningfully chains quantitative and qualitative methods, as well as provides a useful means to generate new hypotheses for future games and learning research.

## Introduction

In recent years, games and learning research has often focused on the important role that these forms of interactive media may play for understanding situated forms of learning and literacy within contemporary media cultures. And yet, much remains still unexplored in terms of determining efficacious ways to employ and synthesize multiple methodological approaches toward uncovering learning in complex game play environments. If a goal for this growing field is to understand how the play of games gives rise to learning practices, we posit that it is important to better understand levels of analysis in capturing the learning present within game play. We are faced with the critical task of understanding the appropriate lenses by which we can investigate learning practices, as well as how to connect the insights learned through each.

In the present study, we describe a multi-methodological approach to the understanding of learning, illustrating the connections between methods through the analysis a single case of game-based learning: the forms of computational thinking that arise during the play of *Pandemic* (Leacock, 2007), a collaborative board game. Through a multi-site study of player talk through multiple runs of the game, we attempt to uncover learning on multiple scales, with three major methodological approaches employed. In doing so, we attempt to delve into the variety of learning practices and activities engaged upon by participants by “triangulating learning” through the use of three approaches: content analysis, learning analytics, and d/Discourse analysis techniques. We hypothesize that a coordinated attempt to understand learning across multiple scales may reveal both how computational thinking is instantiated in the practices of game play as well as how we may usefully focus on multiple scales of analysis to investigate learning in games.

In the following sections, we first describe the overall program of investigating computational thinking in *Pandemic*, then a brief description of each of these three approaches, finally discussing lessons learned on the applicability of these approaches for understanding computational thinking (e.g., Wing, 2006; National Research Council, 2010). We attempt to further the goal of better connecting multiple methodological approaches for the explication of learning with games (be they digital or otherwise), while investigating what this combination of analytic techniques may tell us about understanding learning in play-based spaces.

## Computational Thinking in *Pandemic*

Berland and Lee (2011) established *Pandemic* (Leacock, 2007) as an interesting and important site for investigating computational thinking in games. A collaborative strategic board game, *Pandemic* requires between one and four players in the basic game, all working together to rid the planet of four diseases concurrently ravaging the globe. Each player adopts a different role in the game, with different abilities but a common goal of clearing the board of the diseases (participants either achieve this goal collectively, or all fail). As the game is entirely collaborative, it has served as a useful site to capture the ways that complex problem-solving practices are embedded within an off-the-shelf game’s play, and are exhibited through discussion.

In a series of studies conducted at two universities in 2010 and 2011, we studied how participants played *Pandemic*, focusing on the forms of computational thinking displayed in their verbal exchanges

while playing the game. We created new rule manipulations intended to elicit different computational thinking practices (including “Strategy Debugging,” “Rules Debugging,” “Simulation,” “Algorithm Building,” “Conditional Logic”; see Table 1 below). In each case, all talk during the game was recorded, broken down by turns in the game, and matched with individual participant roles within the game.

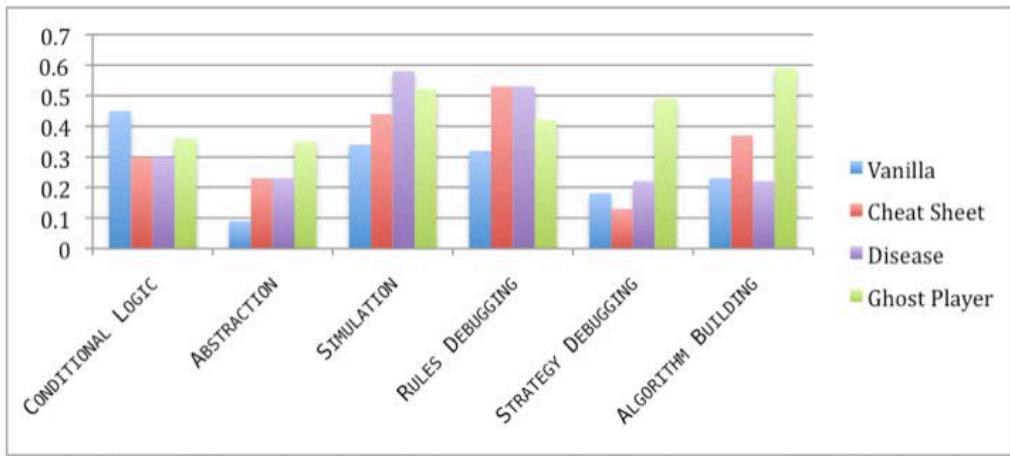
	<b>Site</b>	<b>n</b>	<b>Additional Rule</b>	<b>Hypothesized Change in Comp Thinking</b>
Group 1	Texas	4	No Rule Change/ “Vanilla”	Control Group
Group 2	Texas	3	No Rule Change/ “Vanilla”	Control Group
Group 3	Texas	3	“Cheat Sheet”	Increase in <i>Strategy Debugging</i>
Group 4	Texas	2	“Cheat Sheet”	Increase in <i>Strategy Debugging</i>
Group 5	Ohio	3	“Ghost Player”	Increase in <i>Simulation</i>
Group 6	Ohio	2	“Ghost Player”	Increase in <i>Simulation</i>
Group 7	Texas	2	“Disease”	Increase in <i>Rules Debugging</i>
Group 8	Texas	4	“Disease”	Increase in <i>Rules Debugging</i>

**Table 1: A breakdown of all eight groups.**

And yet, with this raw data, multiple scales of analysis presented themselves as useful for understanding computational thinking within this environment. In the following sections, we outline three approaches, connecting nomothetic (between-subjects, analyzed in the aggregate) to idiographic (focused on the individual) approaches, first applying content analysis coding schemes to understanding the prevalence of computational thinking practices. Next, building upon the content codes, learning analytics approaches were employed toward investigating idealized paths through the problem spaces of the game. Finally, from these, d/Discourse analyses are used to capture specific meaning-making exchanges within the gaming transcripts. In the following sections, we will trace one chain from content analysis to learning analytics to d/Discourse analysis from data in the ongoing computational thinking in *Pandemic* research, as a means of illustrating the connections between methodologies and scales of analysis. For details on the specifics of computational thinking within collaborative board games, we suggest the reader reference Berland and Lee (2011) or Berland and Duncan (2012)—for the purposes of this paper, the emphasis will be on methodological concerns and ways to connect multiple scales of analysis.

## Content Analysis

As detailed in Berland and Lee (2011) and in Berland and Duncan (2012), an early inclination with studying computational thinking in this domain is to first characterize the prevalence of computational thinking in game play, as assessed using an *a priori* coding scheme (a la Steinkuehler & Duncan’s, 2009, assessment of informal scientific thinking in online gaming spaces). With this approach, the prevalence of each hypothesized code was determined, as well as the differences between each experimental condition (different rule manipulation, as in “Vanilla” or “Cheat Sheet”). A set of four coders iterated a computational thinking coding scheme, coding 366 player-turns (6870 individual utterances), and achieving an inter-rater agreement of over 95% on this coding scheme. Please see Figure 1 below for a simplified breakdown of the results from this stage of analysis.



**Figure 1: Content analysis code saturation by condition.**

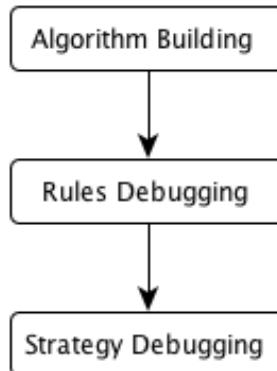
As can be seen in this graph, analyses of this sort are necessarily conducted in the aggregate—participant talk is coded by turn, tallied for each of the codes, and then assessed both graphically as well as for statistical regularities (see Berland and Duncan, 2012, for detailed analyses beyond the scope of this paper). In sum, the approach laid out here is nomothetic in nature—aimed at addressing the overall prevalence of computational thinking practices, and assessing the influence of modifications to the game in a between-subjects manner.

How might we use these data and analyses, then, to help us move past a scale of analysis that characterizes the collection of design talk in the *aggregate*, while valuing the lessons learned from this level of analysis? In the next section, we outline an approach that builds upon the content analysis to provide a hypothesized idealized path through the problem space of the game.

## Learning Analytics

One useful approach is to focus on “learning analytics,” or hypothesized, idealized path based upon the data gleaned for the content analysis scale of analysis. If the first stage is to identify regularities and patterns in the entire corpus of talk present within the game, the next is to develop generalized insights that help us to understand not all of the activities present within the play of *Pandemic*, but instead a “distilled” set of these computational thinking practices, connected into a path of activities.

To determine a *trace* (as per Berland, Martin, Benton, Ko, & Smith, submitted), we found the most likely transitions between “types” of logic. This is an exploratory measure designed to further highlight relationships between these data. In this case, we were interested in an ordering of the computational thinking codes in the data. To determine the ordering, we collected all of the instances in which a turn showing a particular code (say, Algorithmic Thinking) followed another turn with a different code (say, Conditional Logic); this is called a (first-order) *transition*. A second-order transition would find all of the instances in which one code followed another code then followed another code. We computed the complete set of first- and second-order transitions for our dataset and solved for the highest likelihood ordering of transitions (1). This method allows us to see broader-scale relationships across our dataset so as to identify patterns to investigate more thoroughly at the discourse level. Below, in Figure 2, we present the elements of a trace focused on “Strategy Debugging.”



**Figure 2: A learning “trace” abstracted from learning analytics methods.**

In the *Pandemic* work, we first identified the prevalence of these computational thinking practices, then employed a second-order, computational method for tying these codes to one another. By creating a hypothesized chain computational thinking practices (of Algorithm Building → Rules Debugging → Strategy Debugging), we argue that learning analytics provide a useful “glue” between nomothetic and idiographic approaches, serving as to filter insights developed from content coding to further justify the selection of data to qualitatively analyze using d/Discourse analysis methods.

### d/Discourse Analysis

Using the Algorithm Building → Rules Debugging → Strategy Debugging chain, we can now apply conclusions drawn from Learning Analytics toward the *selection* of data for qualitative analysis. As Duncan (2011) argued, d/Discourse analysis methods—including Gee’s (2010) “big-d Discourse analysis”—suffers from the problem of how one justifies the selection of data to analyze. That is, if it is important to connect insights gained from *idiographic* methods to other means of understanding game-based learning (and scales of analysis), then determining principled ways of selecting the data for such analyses becomes a critical task.

In the case of computational thinking in *Pandemic*, we can take what’s learned through the Learning Analytics approaches to find an exchange of interest. In this specific case, it means following the chain from content analysis (determining the prevalence of computational thinking codes) to learning analytics (determining an idealized path through the problem space of the game) through to a case of the talk between participants that fits the idealized path. While typicality is clearly not the only means of justifying the selection of data for d/Discourse analyses, the chain of previous analyses leads the researcher to investigate how meaning is made and negotiation occurs in the course of some of the most common moments in the play of game.

Take, for example, an Algorithm Building → Rules Debugging → Strategy Debugging chain found in the *Pandemic* data: turns 9 through 11 of Group 6 (see Table 1, above). In this case, the game was taking a turn for the worse—two players (“White” and “Red”) had misunderstood an earlier rule that was now beginning to impact their game, and in turn 10, in particular, they attempted to debug the rules that were clearly beginning to malfunction (and impair their progress). A selection from Group 6, turn 10, is replicated below, focusing specifically on terminology used to flag individual actions (in *italics*; emphasis ours) with group strategies/actions (in **bold**) and actions of a “Ghost Player” controlled by both other players (underlined):

- 1 - White: “Okay, *my* turn. *I*’ll take out Cairo first, since **we** just drew that card, 1,2,3 - so three turns. Should **we** take out all 4 in Cairo, why not? **We** don’t have anything else to do.”
- 2 - Red: “Yeah.”
- 3 - White: (reading card) “Research station..” Oh wait, where should **we** add it? Here? No, it doesn’t matter...”
- 4 - Red: “Okay, here.”
- 5 - White: “... then draw 2 of these...”
- 6 - Red: “...alright.” (moves game tokens and cards)

- 7 - White: "Okay, take 1, 2, 3, cure disease - in order to cure disease you play 4 cards and now (reads cards & moves cards) St. Petersburg, add 3 cubes to any city, which one is it? Wait a sec - if the epidemic causes... but we have the cure for it, don't we?" (grabs instruction book)
- 8 - Red: "Doesn't it mean..." (looks to instruction book) "Let's just go over the cure..."
- 9 - White: "I don't know..." (reads from instruction book) "... if your pawn, discovered cures..."
- 10 - Red: "Oh, okay, we've eradicated it."
- 11 - White: (reading from book) "...cards of this color... okay, it doesn't matter, so screw the blue card."
- 12 - Red: "Even though we are in epidemic?"
- 13 - White: "Yeah, that was on there, I think that's all it means is, it's on the (points to board)
- 14 - Red: "Okay, yeah, alright..."
- 15 - White: "Is it your turn?"
- 16 - Red: "You just went?"
- 17 - White: "He just went, we eliminated this disease now."
- 18 - Red: "Yeah."
- 19 - White: "So, we're done with blue..."
- 20 - Red: "I say - um - I mean it's your -"
- 21 - White: "Your turn, it's 6 cards now, we can't toss 7."

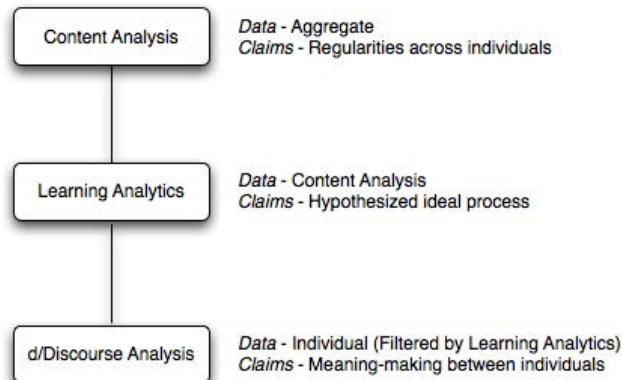
In this exchange, we see an interesting balancing between three individual (two real player, one Ghost Player) and collective actions, while also attempting to unpack the cause of a malfunctioning rule (coded as "Rule Debugging"). In this case, the interesting mixture of individual and collective goals gives way to a set of collective, collaborative goals, before finally turning into confusion as players try to remember whose turn it is next.

We can drill down past the aggregate or even hypothesized traces through the content codes, and investigate the specific exchanges that may serve as foundational for potential further studies. In this case, a cursory examination yields an interesting interplay between participants over strategies—White first lays out a strategy for both him and Red to enact (utterances in lines 1-7). Next, as confusion arises over the game's rules (end of line 7), both players refer to the game's instructions in order to clarify it, and, most interestingly (lines 15-21) end the turn with confusion over their individual roles in the game ("Is it your turn?" in line 15, and "I say - um - I mean it's your -" in line 20). Thus, a new hypothesis emerges—a focus on Rules Debugging may be correlated with a focus on the collaborative goals, and thus confusion regarding individual strategies and responsibilities.

By "drilling down" from the content analysis to the learning analytics and then to a d/Discourse analysis level, the framework outlined here both fleshes out exchanges that may not have been adequately capturable with a nomothetic approach such as content analysis, and provides future avenues for investigation into the nature of collaborative problem-solving and computational thinking.

## Multiple Scales of Game-Based Learning

As we have argued through this brief example, much can be learned through the exploration of multiple methods, and the principled connection of methods toward the investigation of different levels of complex learning practices in games. In Figure 3 below, we can lay out a general framework for connecting these three methods, as well as identifying the forms of data that are applicable to each method, as well as the kinds of claims/uses of each scale of analysis.



### **Figure 3: A general framework for connecting methods and scales of analysis.**

Though at this point this is a provisional framework, it does lead us to suggest that there is utility in specifying the ways that different methodologies connect to provide a better understanding of the different levels of complex reasoning that occur in game-based learning. In the case of *Pandemic*, we can develop a characterization of the aggregate activity through the use of content analytic approaches, while using learning analytics methods in a more-or-less instrumental fashion, to clarify ideal paths through the problem space of the game and to justify the selection of data for d/Discourse analyses. Connecting the nomothetic and idiographic approaches in this fashion allows the research to address both the typicality of a particular kind of learning practice, as well as raising new questions about the phenomena under study often best uncovered through a careful read of individual exchanges.

In general, developing principled ways of connecting multiple levels of analysis and employing multiple methods can help us to (1) justify the selection of data used in qualitative methods used to uncover learning and literacy in game spaces; and (2) give us cause to investigate the ways that complex problem-solving and learning may instantiate in very different ways at different levels of analysis. In game-based learning in particular, there is an increasing call for researchers to quantitatively justify claims about the productive potential of these media, while at the same time, many of the most intriguing learning practices are best uncovered through qualitative analysis. We argue that formally connecting the quantitative and qualitative may help to address both the need for “harder” data to substantiate claims of game-based learning, while also addressing the socially- and culturally-situated forms of learning that are part and parcel of engaged gaming talk.

### **Endnotes**

- (1) While this trace is generated from the Markov chains, it is not itself a Markov chain (for more detail, see Berland, Martin, Benton, Ko, & Smith, submitted).

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# A Framework for Conducting Research and Designing Games to Promote Problem Solving

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**Abstract:** While problem solving is lauded as a benefit of video games, little empirical evidence exists to support this assertion. Current definitions and taxonomies are often contradictory and do not capture the complexity and diversity of modern games. Many video game researchers are also unfamiliar with the 75+ years of problem solving research in Europe and the United States. We propose a classification of *gameplay* that accounts for the cognitive skills during gameplay, relying in part on Mark Wolf's concept of grids of interactivity. We then describe eleven problem types and the dimensions along which they vary. Finally, we use the shared dimensions of gameplay and problem types to align gameplay types and problems. We believe that this framework for thinking about games and problem solving can guide future design and research and design on problem solving and games.

## Statement of the Problem

Many have argued that games address critical thinking and problem-solving skills (e.g., Gee, 2007; Greenfield, 2010; Van Eck, 2006 & 2007). Unfortunately, what research exists on this tends toward the descriptive rather than the empirical. Descriptive analysis can illustrate how some kind of problem-solving *process* is occurring within a game (e.g., scientific method), but it cannot tell us about the *kind* of problems, how often they occur, for how long, and, most importantly, how effective a given game is at promoting problem solving skills.

Unfortunately, we are not prepared to conduct the kind of research that will answer these questions. Current game taxonomies are inconsistent and often contradictory, having their origins in film studies and relying on common parlance. Conducting empirical research on problem solving and games will require that we be able to manipulate and control for different types of games so that we can examine what *kinds* of games promote problem solving better than others. At the same time, we recognize that games that share the same genre can be very different experiences and that some games cross genre boundaries (e.g., action-adventure). Even were this not the case, any given game is likely to vary in terms of pace of play, amount of interactivity required, number of problems presented, and so forth. These are differences that must somehow be accounted for if we are to examine how any given game impacts problem solving.

This challenge is compounded by a lack of awareness on the part of most serious games researchers regarding existing problem types and problem-solving research. We require the same level of precision in our treatment of problem solving as we do in our definition of game typologies. To design a game to promote problem solving, we must know what kind of problem we are interested in: creating a menu for guests who have different diet restrictions, troubleshooting a car that won't start, diagnosing a patient's back pain problem, or solving global warming? Each type of problem differs significantly in structuredness, requirements for prior knowledge, ability to embed other subproblems, and cognitive structure, and therefore require different means of instruction (or game design).

Fortunately, cognitive psychology and instructional design have been studying problem solving for many years, and a rich body of research exists which can help inform our studies and design of problem solving in games. In this chapter, we attempt to bridge theory and practice by examining the relationships between games, problems, their cognitive processes, and instructional design.

## Problem Solving

It is generally accepted in cognitive psychology that a problem has an initial state and a goal state. The initial state is the set of information and resources present at the beginning of the problem. The goal state is the information and resources that will be present when the goal has been met. The problem solver uses a representation of that goal state when considering how to proceed, which usually takes the form of doing things to reduce the disparity between the initial state and the goal state. The strategies s/he uses and the process by which s/he thinks about moving toward the goal

state within the constraints of the problem and his/her prior knowledge are collectively referred to as the problem space. Most recently, Jonassen (2000, 2002) and Jonassen and Hung (2006, 2008) have proposed a typology of problems and associated prescriptions for the design of problem-based learning and instruction to promote problem solving in general. If games themselves are examples of problem solving, they should share to the same kinds of characteristics as different problems have. A closer inspection of this literature to see if and how it can be mapped to the study and design of serious games may yield important findings.

## **Games and Problem Solving**

Jim Gee (2007) has argued that all games are situated, complex problem solving, and others have made the same point (e.g., Kiili, 2007). The core of our argument is that problems are highly differentiated by context, purpose, and domain, that different types of gameplay have their own affordances, and that it is necessary to understand problem types and gameplay types in order to align them meaningfully in the design of games to promote problem solving, or to conduct research on the effects of gameplay on problem-solving skills. There are three dimensions upon which a problem itself may vary: structuredness, cognitive components, and domain knowledge. Space does not allow a full accounting these dimensions, and the reader is referred to our work on this elsewhere (Hung & Van Eck, 2010). Likewise, we rely on an in-depth analysis of gameplay types, which we are able only to touch upon here, and the reader is referred to the aforementioned chapter for full accounting of gameplay types and interactivity.

## **Problem Structuredness**

Jonassen (1997) argues that structuredness describes the *reliability* of the problem space in terms of the ratio of the information about the problem known and unknown, the number of variables, the number of possible solutions, and the degree of ambiguity involved in being able to assess one's success in solving the problem. Video games (or, more precisely, the gameplay that makes up different video games) also vary on a continuum from highly structured to poorly structured, so structuredness becomes one dimension upon which we can categorize both games and problems.

## **Cognitive Processes in Problem Solving**

Solving different problems also relies on different kinds of cognition. There are six main cognitive processes relevant to problem solving as we discuss it: Logical thinking (the mental process that infers an expected event as a result of the occurrence of its preceding event or evaluates the validity of the conditional relations of these events); analytic thinking (identifying and separating an object, essay, substance, or system into its constituent components, examining their relationships as well as understanding the nature, behaviors, and specific functions of each component); strategic thinking (an integration process of synthesizing and evaluating the analytical results of a given situation and generating the most viable plan with intuition and creativity); analogical reasoning (the mental process by which an individual "reason[s] and learn[s] about a new situation (the target analogue) by relating it to a more familiar situation (the source analogy) that can be viewed as structurally parallel" (Holyoak & Thagard, 1997); systems thinking (the cognitive reasoning processes that consider complex, dynamic, contextual, and interdependent relationships among constituent parts, and the emerging properties of a system, (Capra, 2007; Ossimitz, 2000); and metacognitive thinking (the cognitive process that an individual is consciously aware of and which he or she articulates to various aspects of his or her own thinking processes). Different problems and different kinds of gameplay will support these types of thinking in different ways. Therefore, they become important for understanding how gameplay and problem solving can be aligned.

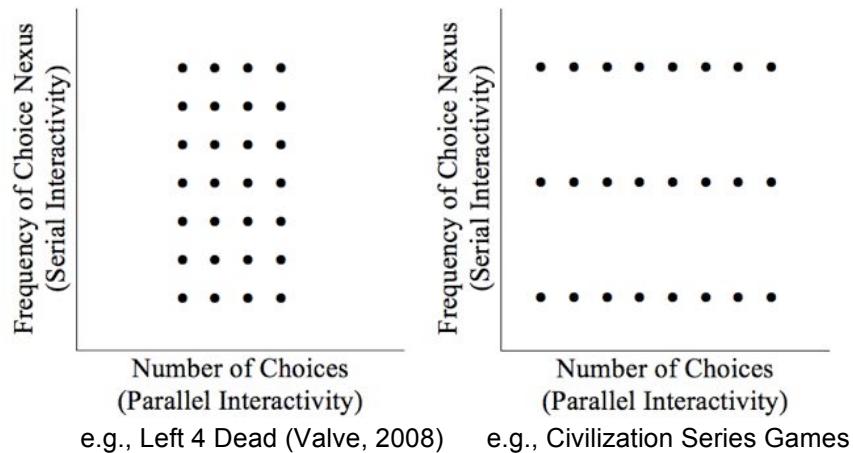
## **Classifying Gameplay Types using iGrids**

The variance of problems along dimensions of structuredness and cognitive processes presents one challenge to the research and development of games for promoting problems solving. Yet games themselves vary greatly as well, as can be seen in classification systems (e.g., Apperley, 2006; Frasca, 2003). And because no one classification system is widely accepted nor completely compatible, our task is made even more difficult. Games often employ multiple gameplay strategies from different genres within the same game, leading to hybridized descriptions like action-adventure that work against meaningful classification. So how are we to distinguish among games (or types of gameplay) in a way that makes possible the empirical research and design of games to promote problem solving? While serious game researchers may not agree on different game genre classifications, most might agree that interactivity is one of the hallmarks of video games. This provides one means of classifying gameplay in a way that crosses all game types:

The smallest unit of interactivity is the choice. . . . Choices are made in time, which gives us a two-dimensional grid of interactivity that can be drawn for any game. First, in the horizontal direction, we have the number of simultaneous (parallel) options that constitute the choice that a player is confronted with at any given moment. Second, in the vertical direction, we have the number of sequential (serial) choices made by a player over time until the end of the game (Wolf, 2006).

Wolf (2006) calls this a Grid of Interactivity, and we refer to them as iGrids. Frequency of choice and number of choices make good initial measures of pace, complexity, and cognitive load, and we believe these constructs impact problem solving and problem typology differentially. Wolf points out that it is not possible to map an entire game space on a graph, nor do we mean to suggest they otherwise. Nonetheless, such plots remain a useful tool for conceptualizing the issue of interactivity and one which we can rely on as a first step to further defining the kinds of gameplay that differentially support different problem types.

Although genre-based taxonomies of games are problematic, for now we will refer to genre-based terminology for the purposes of illustration. To understand an iGrid, imagine Aristotelian archetypes of different game genres such as “action” and “simulation” (see Figure 1).



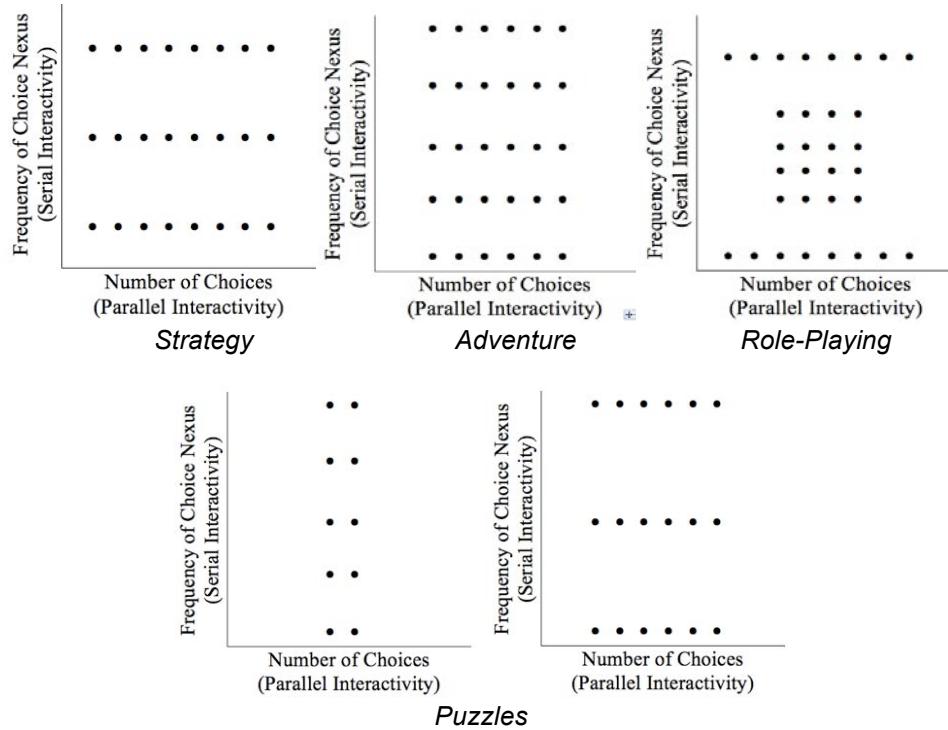
**Figure 1: iGrids for two different gameplay types.**

The x-axis represents parallel interactivity, which is the number of choice options a player has at a given point in time (called a choice nexus), while the y-axis represents how often the player is presented with a choice nexus. For example, the game represented by the iGrid on the left of Figure 1 forces the player to make choices frequently over the course of the game with little time *between* choices but presents *few options* to choose from at those points. In the iGrid on the right, we see a game that presents *many options* to choose from but which forces the player to make choices *fewer times* over the course of the game with long periods of time between choices. Of course, there are action games with more parallel choices (e.g., weapons, running vs. hiding, inventory, armor, etc.) and periods of gameplay with lower choice nexus frequency. Likewise, games like those in the Civilization series *allow* near-continuous serial opportunities for interaction, but they do not *require* it.

iGrids, as measures of gameplay, become useful tools for discussing the differences in games that are likely to impact learning. While not sufficient on their own to fully delineate different types of gameplay, they at least provide an additional point of reference for communicating what is meant by whatever labels we use to describe games (e.g., action or strategy). Further, and most importantly, they allow us to describe *gameplay*, which after all can vary dramatically over the course of a single game. It will be important to be able to describe the key characteristics of gameplay in our quest to measure the ability of different types of gameplay to promote different types of problem solving.

By combining iGrids with an analysis of game/gameplay types using the same dimensions and characteristics that are used to differentiate problem types, we are able to develop a framework for describing games/gameplay that makes further study possible. In our discussion, we will rely on terminology regarding gameplay, which we have fully articulated elsewhere (Hung & Van Eck, 2010). Rather than generate new terminology and labels for the resulting taxonomy, we rely on existing

taxonomies (e.g., Apperley, 2006) with some modifications. The resulting classifications are in some cases significantly different than common parlance, however. For example, Frasca's (2003) classification would list *SimCity* and *Flight Simulator* as simulations, whereas our analysis of gameplay suggests that *SimCity* is a strategy game (optimizing a system by strategically balancing factors) and *Flight Simulator* is a simulation game (a test of coordination of perception, cognition, and muscular control). Likewise, Apperley's classification would put *FIFA Soccer* and *SimCity* together as simulations, whereas we maintain that by virtue of gameplay and cognitive characteristics, *FIFA Soccer* is an action game. Space does not allow a full accounting of game play types (Action, Strategy, Simulation, Adventure, Role-Playing, and Puzzles), but Figure 2 presents the iGrids for each type. It should be noted that our categories are not intended to represent entire games as products; any given game will embed a variety of these different gameplay types as the situation warrants. But by focusing on the essential characteristics of gameplay *at any given moment*, we can make better determinations about what kinds of learning activities may or may not be best supported at a given time. The full analysis of by which we arrive at these different gameplay types can be seen in our previous work (Hung & Van Eck).



**Figure 2: iGrids for five other gameplay types.**

### Problem Typology

Now that we have outlined our gameplay typology, we turn our attention to problems themselves. Jonassen (2000) has constructed a comprehensive typology consisting of 11 types of problems:

- Logical problem
- Algorithm problem
- Story problem
- Rule-use problem
- Decision-making problem
- Troubleshooting problem
- Diagnosis-solution problem
- Strategic performance problem
- Case analysis problem
- Design problem
- Dilemma problem

Space does not allow for a full accounting of all these problem types and examples. The reader is referred to Jonassen's text referenced above, as well as our previous work (Hung & Van Eck, 2010).

Suffice it to say that each of these problem types varies along key dimensions of cognitive composition (e.g., types of reasoning), structuredness, and requirements for domain-specific knowledge.

Blending these dimensions with iGrids and our analysis of gameplay types, including game-specific dimensions like psychomotor skills and the affective domain, it becomes possible to align problem-types and gameplay types along the dimensions that both share, and thus propose a framework for which kinds of gameplay types will support which kinds of problems, best (see Figure 3).

Knowledge and Cognitive Process														
	Domain-specific knowledge <sup>1</sup>				Higher-order thinking			Psychomotor skills <sup>2</sup>		Attitude change <sup>3</sup>				
Problem type ↓	Declarative	Procedural	Concepts	Principles	Logical	Analytic	Analogical	Strategic	Systemic	Metacognitive	Muscular movement	Muscular-cognitive coordination	Shift of belief system	Game type ↓
Logical					+ +									Adventure; Puzzle
Algorithmic	+	+	+	+										Adventure; Puzzle; Action
Story	+	+	+	+	+	+	+							Adventure; Puzzle
Rule-use	+	~	~	+	+	+								Action; Strategy; Roleplaying; Adventure; Puzzle
Decision-making	~	+	+	+	+	+	+	~	~					Action; Strategy; Roleplaying; Simulations; Adventure
Troubleshooting	+	+	~	+	+	+	+	~	~					Simulations
Diagnosis-solution	+	+	+	+	+	+	+	+	+					Simulations; Strategy
Strategic Performance	+	+	+	+	+	+	+	+	+	+				Action; Roleplaying; Simulations; Adventure
Case Analysis	+	+	~	+	+		~	+					~	Strategy
Design	+	+	+	+	+	+	+	+	+					Strategy
Dilemma	+	+	+	~	+	+	+						+	Strategy; Roleplaying

1 For Psychomotor Skills and Attitude Change: domain-specific procedural and principle knowledge and metacognitive thinking are assumed.

2 For the learning type under Domain Knowledge, application of the knowledge is also assumed in this chart.

~ signifies “always required.”

~ signifies “sometimes required.”

**Figure 3: Framework for aligning problem and gameplay types.**

This allows for both the design of games to promote specific kinds of problem solving and for the design of research to test the effects of varying specific kinds of gameplay on different kinds of problem solving. We can then also examine things like varying pace of play, frequency of problem solving, length of play over days, and other variables to establish heuristic design models and an empirical research base on problem solving and games. Knowing about different problem types allows us to see existing games in a new light. For example, dilemma problems can be seen in persuasive games such as *Darfur is Dying* (mtvU, 2009). But more importantly, knowing how those problem types themselves vary along the dimensions of domain-specific knowledge and required cognitive processes shows us that what superficially may appear to be similar games are in fact quite different in terms of their ability to support problem solving. For example, many might say that *September 12* (Newsgaming.com, 2003) and *Darfur is Dying* are both dilemma games, when in fact *September 12* is too well structured and stripped of context to fully support dilemma problems.

Relying on iGrid typologies of gameplay rather than on genre classifications similarly promotes more precise analyses of games and problem solving. By focusing on archetypal gameplay styles, we can see how strategy and role-playing games seem best suited for dilemma problems, for example. Further, we are able to apply this reasoning to hybridized games that might at first glance appear to not support different kinds of problem solving. Space does not allow a full accounting of every problem type and every gameplay type (iGrid), nor how they each are aligned but this general description and the following example may suffice to illustrate the logic behind blending problem and game typologies.

Extending our example of the dilemma problem, the game *Bioshock* (2K, 2007), which many might categorize as adventure-action hybrid, is in fact a hybridization of action, adventure, and strategy. The game *Bioshock* pits the player against a variety of challenges in an underwater city named Rapture. As with *Left 4 Dead* (Valve, 2008), the player must make their way through the city without being killed by Big Daddies (giant modified humans in diving suits) and demented humans while collecting weapons and resources. Among these resources are plasmids, which grant special powers by virtue of genetic modifications, and which are injected via syringes. They key to unlocking the powers of plasmids lies in the collection of ADAM, which can only be obtained in the game from Little Sisters, who appear to be preadolescent girls. Little Sisters are always accompanied by Big Daddies, who must be killed before the player can collect ADAM. The dilemma problem in the game occurs with the decision on how to harvest the ADAM. One way results in the death of the Little Sister but results in a large amount of ADAM. The other way saves the Little Sister but results in less ADAM. While this choice seems to be pretty simple (two choices) the choices have a significant impact on the difficulty of the game and the way it proceeds. Additionally, whereas the binary choice in *September 12* (Newsgaming.com, 2003) is limited to the same instances and has the same results easily seen in a short period of time, in *Bioshock* these choices are distributed over the course of up to 50 hours of gameplay with relatively high frequency (medium serial interactivity), and the effects of these choices are not fully realized until near the end of the game. Thus, it is possible to support dilemma problem solving across the full arc of a game which itself is interspersed with other gameplay types, which in their own right may support other kinds of problem solving.

Finally, while our purpose is to outline a mechanism by which problem types with their associated cognitive requirements can be matched to different styles of gameplay, the end result also provides significant guidance for design and development of the games themselves. Because the study of problem solving within education and instructional design has been going on for decades, a rich body of research and best practices exists for supporting problem solving. Knowing, for example, that a problem is highly structured implies that less support should be provided for its solution, while ill-structured problems will require addition scaffolding and strategies to avoid cognitive overload. On the other hand, well-structured problems that occur during games with hybridized gameplay styles may indicate the need for more support than otherwise. When the problem solving itself is driving the game design, we may deliberately modify the form and frequency of a different gameplay styles in order to better support the problem (once we have conducted the empirical research to know how to promote different problem types, that is!). Knowing the kinds of cognitive processes involved also may help guide our selection of in-game tools, story structure, and objectives as well.

If we are to build games that promote problem solving, we must build on existing problem solving research. If we are to make claims about problem solving and games, we must generate new research and design heuristics based on the alignment of problem solving and different gameplay types, and test those empirically. In this paper, we have outlined a way to begin to meet both of these challenges. We used Jonassen's typology of problem types to help analyze the cognitive processes involved in different types of gameplay and, in turn, dissected gameplay that brought the essential characteristics (for problem solving, at any rate) to light. With an understanding of the cognitive, physical, and domain knowledge requirements of each type of gameplay, instructional designers and game developers will have a better idea of what types of gameplay will most appropriately afford given problem-solving learning goals and objectives.

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# Beyond Collaboration and Competition: Independent Player Goals in Serious Games

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**Abstract:** Many serious games simulate critical issues, such as social justice, ecological sustainability, and economic inequity using collaborative and competitive rules. However, in real life, these situations often are not purely collaborative or competitive. Rather, they may involve many actors who have individual goals but must share social systems and common resources. This research demonstrates how independent goals in games support the emergence of cooperative, collaborative, and competitive interactions characteristic of these real life situations. Computer simulations and human playtests of *The Farmers*, an original tabletop game with independent goals, are compared to collaborative and competitive variants. These comparisons indicate that independent goals lead to play styles distinct from collaborative and competitive variants.

Tabletop games in which players win or lose independently of how well or poorly other players do are extremely rare. More common are games in which a player's success requires another player to lose (competitive games) or the entire group to win (collaborative games). In contrast with these games, achievement in life can be independent or at most tangentially related to others' success.

In life, conflicts and coalitions are not usually predefined. Rather, they more often emerge within shared economic, political, and social systems. This can happen when actors disagree or agree about notions of justice, fair resource use, and rights of access in those systems. Tabletop games offer a method for simulating interconnected economic, political, and social systems in which conflicts between actors can emerge. Furthermore, simulations can be used to illustrate how cooperation can emerge between actors that share goals or believe that cooperating around goals is in the mutual best interest or ideologically beneficial.

Many of the most important cases to simulate for educational and research purposes are *social dilemmas*, situations in which an actor is forced to choose between acting in self-interest and the interest of a common group (Kollock, 1998). One specific kind of social dilemma is the *common pool resource dilemma*. Common pool resource dilemmas are situations in which several actors can freely access an area of common resources and use those resources for personal benefit. Fisheries are an example of common pool resource. They are not owned by anyone, are openly accessible, and difficult to regulate. When too many fish are removed, the result can be the depletion of the fishery. This can happen because many people have personal incentive to take from the commons even though this action is not sustainable and not desirable for humanity. When a commons is affected negatively in this way, this is known as a *tragedy of the commons* (Hardin, 1968). Understanding how to deal with and prevent the tragedy of the commons is one of the most urgently important topics in scientific research (Ostrom, 1999). Smith (2006, 2007) examined the emergence of the tragedy of the commons in online games, but did not examine games that specifically have mechanics that support the emergence of the tragedy of the commons.

This research examines *The Farmers*, a common pool resource dilemma game that accounts for several elements that support play that is not purely collaborative or competitive. *The Farmers* employs the use of shared resources, complementary abilities, and varied goals among players that lead to interactive synergies, which support the emergence of cooperation (El-Nasr, et al, 2010; Rocha & Mascarenhas, 2008; Zagal, Rick, & Hsi, 2006). Finally, *The Farmers* discourages *pyrrhic victories*, situations in which being ahead of others is not a victory if the world is destroyed as a result of actions taken to come out ahead.

## The Game

*The Farmers* is a card game (see Figure 1a) in which three players harvest and plant resources in a common space (see Figure 1b). These resources include trees, which protect against floods, wheat and pasture lands. Each round, land in the commons may be eroded if there are not enough trees. Players do not want erosion, but have a personal incentive to take from the commons to gain points (therefore increasing the likelihood of erosion). Each turn, the three players take one action: either

harvesting, planting, gaining a point, restoring eroded land, or sanctioning (see Figure 1c). After actions occur, the commons react to the modifications that have been wrought by the players, negatively impacting everyone if the land has not been managed sustainably. Players have unequal abilities and different desires, and are often not the best at planting or harvesting the resources they most desire.



**Figure 1a:** A computerized version of *The Farmers* game.



**Figure 1b:** The commons in *The Farmers*.



**Figure 1c:** A player's hand in *The Farmers*. They have options for planting and harvesting each of the three resources (trees, wheat, pastures) and may also sanction, gain a free point, or restore devastated lands.

In *The Farmers*, players are given independent goals and told to optimize their own personal scores. This means that all players at a table can win, all can lose, or some can win and others can lose. Farmers A, B, and C at one table are compared to Farmer A', B', and C' at another table. Farmer A is playing versus Farmer A', B versus B', and C versus C'. Similarly, when two tables of players are not available, players can compete against preset distributions to compare their score to percentiles of past players. This independent goal setup is different from asking players to combine their score into a group score (a collaborative game) or requiring a player to have the most points at the table (a competitive game). In the independent goal version, there is no interaction or information exchange between tables, keeping the groups completely separate during game play.

## Methods

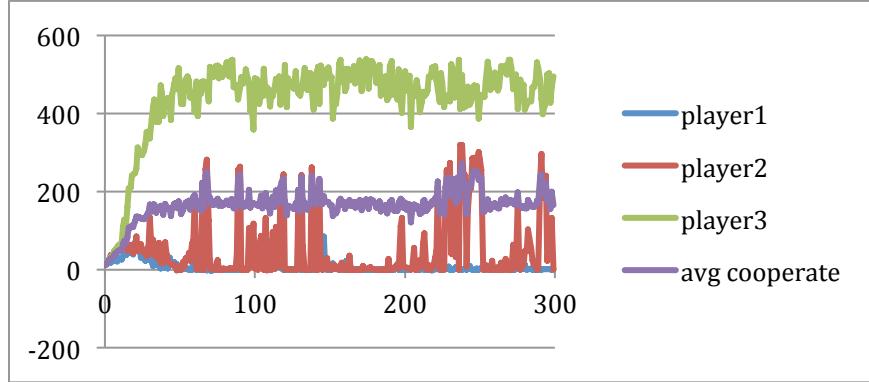
Computational simulations and human playtests of *The Farmers* were performed. One set of tests was done using the independent goal game rules as described above. In addition to the independent goal game, tests were run on collaborative and competitive variants. In the collaborative variant, players were told to work as a group to have a total group score higher than another group. In competitive games, players were asked to simply have a higher score than other players at the same table and to ignore how other players from other tables were doing.

Evolutionary algorithm simulations show that there are drastic differences amongst these variants in terms of optimal strategies and game outcomes. Solutions were assumed to be in the form of mixed strategies. Thus genomes were representative of action probability distributions. The evolutionary algorithm used competition selection with a small rate of permutation and random combination points. The fitness functions were used to differentiate the three types of game play. In the cooperation version, the fitness of each player was calculated as the sum of the scores of all players. In the competition version, the fitness of each player was their score minus the average score of the other two players. In the self-scored version, the fitness was just the score of that individual.

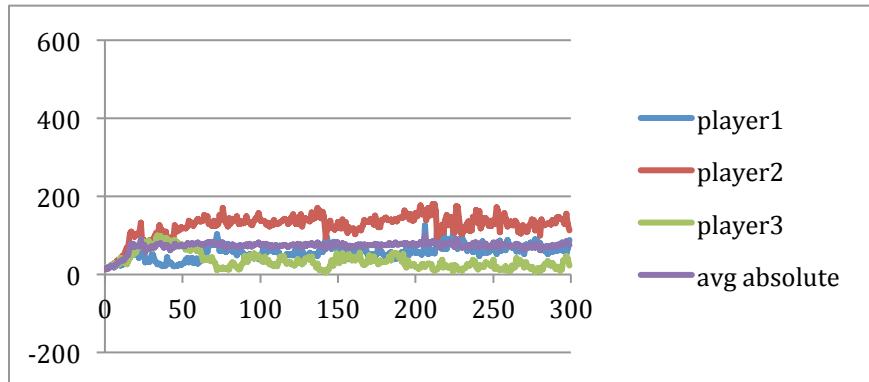
## Computational Simulation Results

Even with such a simple representation of this solution space (ignoring other player actions, time into the game, etc.) the artificial intelligence (AI) agents played quite differently across the versions. In the

collaborative version, combined group scores were high (the average score was about 200 points, making the group score nearly 600 points) but one player scored the majority of the points (see Figure 2a). Because one of the three farmer roles is able to generate more points than others, the optimal strategy in the collaborative game is for the other two players to assist this player in optimizing their collection and therefore their score. In the independent goals version (see Figure 2b), AI players are evolved to optimize personal scores. The total number of points earned for the group is less in the independent goals version (only about 300 points with an average score of 100 for each player) than in the collaborative rules condition, but on the other hand points are distributed more equally among AI players. AI testing thus distinguishes between the collaborative and independent goals conditions.



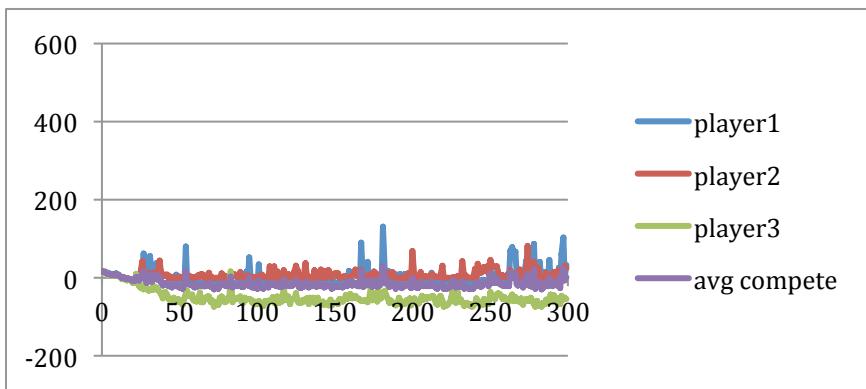
**Figure 2a:** Results of 300 simulations of the collaborative condition.



**Figure 2b:** Results 300 simulations of the independent goals condition.

In the competitive version (see Figure 2c), AI players usually earned far fewer points than they did in other variants both as a group and as individuals. Since they were evolved only to try to earn more points than the other farmers in the same space, and not to earn as much as they could, AI players resorted to actions such as sanctioning to reduce the score of opponents. Unlike in other states in which the land was not often completely eroded, the final state of competitive game simulations was regularly one in which the land was destroyed. AI players evolved selfish and punishing strategies that did not regard the commons simply to maintain a higher score than others. In fact the average scores were close to 0, even negative in many trials. In the competitive condition AI players win as long as they do better—even if their world is destroyed, but a *pyrrhic* victory is not a real victory in the independent goals game, so AI players in the independent goals game evolve cooperative strategies. This shows the independent and competitive conditions to be distinct.

**Figure  
of 300  
of the  
goals**



**2c: Results  
simulations  
competitive  
condition.**

## Human Playtest Results

Human playtests revealed the same play styles and outcomes as the AI simulations. Differences in player communication and interaction patterns were observed between the variants. Human playtest groups were very consistent in collaborating in the collaborative condition and in competition in the competitive condition. However, human playtests of the independent goals version showed a wide range of play styles. Some groups were very aware of the need to work as a group to avoid erosion from the beginning and others not. Players were seen shifting between altruist and selfish play based on the actions of others. Occasionally players in this version chose to sacrifice their ability to take resources, an altruistic act. Some players of the independent goal version of *The Farmers* stated they were constantly emotionally torn between the need to work as a team while still striving to protect their own private interests, while players of the collaborative and competitive variants focused only on their collaborative or competitive goals respectively.

## Conclusions

Human playtests and computational simulations of *The Farmers* suggest that providing players independent goal states leads to play that is genuinely different from both cooperative and from competitive play. Designers of serious games, and in particular designers of tabletop simulation games, may wish to consider using independent (and non-zero sum) goals within game designs.

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# Gaming the Class: Using a Game-based Grading System to Get Students to Work Harder... and Like It

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**Abstract:** Instructors at all levels of the educational system have been experimenting with game-based grading and evaluation frameworks. What is the effect of these grading systems on student motivation and effort? Using well-validated motivation scales to understand how student motivation profiles relate to effort, this paper examines two different instances of game-based grading systems in university coursework. Our findings indicate that a game-based grading system can overcome typical student motivation profiles, essentially helping students—who might normally underperform in coursework—to work harder. We present two contrasting cases: an elective course on video games and learning, and a gateway course on political theory. Findings were similar for both courses, suggesting that game-based grading systems have generalized potential for use in higher education, and possibly beyond.

## Introduction: Games as Model Learning Environments

The Games+Learning+Society community needs no convincing about the power of video games as learning environments. As Gee argued in his seminal book on video games and learning, good games succeed because they tap into our deep-seated desire to learn and be engaged (Gee, 2003). Many of the features of well-designed video games—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—are also features of well-designed learning environments. Various scholars have noted that games can also inspire the design of non-game learning environments, such as traditional classroom-based courses. The work described in this paper was first inspired by authors such as Gee (2003), Prensky (2005), and Jenkins, Squire, and Tan (2003), and crystallized by talks such as Jesse Schell's "Beyond Facebook: The Future of Pervasive Games" (Schell, 2010). Schell described a course taught by Lee Sheldon at Indiana University in 2009 that was both *about* MMO design and *taught as* a MMO course. The process of designing and teaching that course is described in a recent book (Sheldon, 2012). What is made clear in Sheldon's descriptions of his design process across multiple iterations of both his MMO course, and several other courses, is that the *grading system* was one of the most difficult components to design. But is it worth the effort? Do game-inspired assessment systems change students' relationship to the class, essentially leading them to work harder? Will all students work harder, or just certain types of students, e.g., students who would normally work hard anyway?

## Grading Systems and Motivation

Giving and receiving grades is a ubiquitous part of the formal school experience. The most common system of letter grades (A through E) has been a part of education in the U.S. since the late 1800s (Durm, 1993). Students and instructors, moreover, have come to view grades as measures of both learning and performance; schools use grades to sort students by "ability," and this sorting plays an important part of the gatekeeping process used to decide who is given access to funding, advanced study, and jobs. Grades also shape students' self-appraisal. It is unsurprising, then, that after receiving grades, students begin to see themselves through the lens of formal assessment. They become "A" students, "B" students," etcetera. While instructors may view their course designs as a balancing act of pedagogy, assignments, and evaluation, students typically focus only on the grades they receive and how to achieve them. Indeed, an investigation of student performance in Physics courses at one large Midwestern university indicates that the strongest predictor of future student grades is their grades in *earlier* courses (personal communication, T. McKay, September 28, 2011). This suggests a kind of stasis that is hard to overcome once you are within the system, and is likely a function of student self-efficacy.

Motivation, or the study of what pushes individuals to start, sustain, and finally complete activities, is a critical precursor mechanism for learning. We focus here on self-efficacy or academic self-concept as a key component of motivation. We rely on Bandura's (1977) definition of self-efficacy as a cognitive process that mediates an individual's behavior with respect to effort, according to the individual's expected outcomes. As Dale Schunk put it, "Students who hold low self-efficacy for learning may

avoid tasks; those who judge themselves efficacious are more likely to participate" (Schunk, 1990, p. 74). Self-efficacy is a key component of larger theories of motivation, such as attribution theory (Pintrich, 2003) and Dweck's (1975) seminal work on learned helplessness, which posits two different kinds of learners: *entity learners* who believe that intelligence is a fixed property, and assign responsibility for success or failure either to luck or to external circumstances, or *incremental learners* who believe that intelligence is a function of effort, and if they therefore persist, their chances of success increase. Entity learners tend to give up in the face of challenges, while incremental learners persist and (on the whole) exhibit greater self-regulatory capabilities. There is also evidence that the greater one's self-efficacy, the more effort one is likely to exert towards completing a task (Schunk, 1990).

Turning to video games, there is growing (though mixed) evidence that video games increase learners' motivation in various domains, including mathematics (for a review, see Kebritchi, Hirumi, & Bai, 2010). We argue that *good games* (as defined by Gee, 2003) contribute to increased self-efficacy because of the attributes described above, especially the ability to experiment with low costs for failure; at worst, a good game will make you go back to the beginning of the level or start of the puzzle. Good games also place players into a state of flow (Csikszentmihalyi, 2008), increasing time on task, another key element for effective learning. Most frequently, when research on video games focuses on motivation, it focuses on intrinsic or extrinsic motivation within the game and how that encourages students to keep playing or remain engaged (e.g., Lepper & Henderlong, 2000; Malone & Lepper, 1987). We believe that the same motivational theories can be applied to thinking about student effort in formal education, especially when using a game-based assessment system.

Strong research evidence (Ames, 1992; Blumenfeld, 1992; Elliot & Harackiewicz, 1996; Middleton & Midgley, 1997) suggests that students' personal achievement goal orientations are correlated with academic effort and outcomes. Goal orientation theory describes academic persistence in terms of "adaptivity," or how flexible students are to changing demands and expectations in academic settings. Students that have a strong Mastery Goal Orientation, "seek to extend their mastery and understanding. Learning is perceived as inherently interesting, an end in itself. Attention is [therefore] focused on the task. A mastery goal orientation has been associated with adaptive patterns of learning" (Midgley et al., 2000, p. 7). This is the most productive orientation for persistence and learning. A performance-approach orientation is when, "[a]ttention is focused on the self. A performance-approach orientation has been associated with both adaptive and maladaptive patterns of learning" (Midgley et al., 2000, p. 9). This is a middle ground for student adaptivity. A performance-avoidance orientation is when, "students' purpose or goal in an achievement setting is to avoid the demonstration of incompetence. Attention is focused on the self. A performance-avoid goal orientation has been associated with maladaptive patterns of learning" (Midgley et al., 2000, p. 10). This is the least desirable motivational profile because it is most associated with disengagement. These profiles have been identified consistently in learners across many different contexts, and they relate reliably to academic effort and outcomes.

### The Game-inspired Grading Systems in the Current Study

This paper considers student motivation with respect to two different undergraduate courses. The first course is located in the School of Education at a large public research university, and is on the topic of video games and learning. The course is an elective for students, normally taken by upperclassmen from across the university (as opposed to pre-service teachers), with an enrollment of ~80 students. The second course is in the Department of Political Science, and is an introduction to political theory. This course is normally taken by freshmen, with an enrollment of ~300 students. The course is a gateway course that must be passed by any student wishing to major in Political Science. The grading system of each is presented briefly here.

#### *Political Science Course*

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 Graduate Student Instructor (GSI) led discussion sections (20%).

#### *School of Education Videogames and Learning Course*

The goal of the videogames course is to examine the learning and motivational theories that operate within—and inform the design of—videogames. Consequently, the grading system is appropriately infused with the design principles that operate within games. To this end, students enrolled in the videogames course accumulate "experience points" (XP) for each assignment completed. Some assignments can also earn students "skill points" (SP). The course has a set of required assignments that are paired with optional assignments. These assignments are divided into three categories: "Grinding" assignments are those typically characterized as necessary for learning the content, but are not always as engaging as other assignments; "Learning from playing a game" assignments are those that center on students reflecting and commenting on a commercial videogame they have chosen to play throughout the term—their "game text;" "Boss Battle" assignments are longer, more complex, and require a certain level of content mastery to complete successfully. As a result, the "Boss Battles" occur near the end of the term. Optional assignments in this course can be seen either as assignments that students complete to exceed the course's main requirements—because they want an "A+," perhaps—or as assignments that students complete in order to regain points that were lost as a result of missing a class, missing a reading reaction, or simply performing unsatisfactorily on a required assignment.

These two courses and their respective grading systems are different from each other, but both could easily be considered "game-inspired." We also believe that these two courses serve as usefully contrastive cases. One is required, the other is not. One is taken by first-year students, the other mostly by upperclassmen. One is on a "frivolous" topic (at least from the perspective of many students and faculty), and the other is on a "serious" topic. By comparing and contrasting these two classes in terms of student motivation, we stand to learn more about the generalizability of game-inspired assessment systems across topics within a university.

### **Research Questions**

Our study focuses on three main research questions:

- (1) Do the grading systems of these courses help students feel more in control of their grades?
- (2) Do the grading systems in these courses lead students to complete more assignments?
- (3) Do students in these courses believe that the grading systems encourage them to work harder?

In examining these questions, we also explore a number of subsidiary questions related to students' attitudes towards the grading systems and the courses themselves, presented below in the context of our findings.

### **Methods**

We used a survey methodology to gather data on student attitudes and motivation profiles. Data on the Education course is from Winter, 2011. Data on the Political Science course is from Fall, 2012. Both surveys were administered to students near the end of the term. Education students were only given one survey, but Political Science students also had a pre-survey given shortly after the start of the term. We compared responses on both surveys in Political Science, and found no significant differences (the responses were stable across time). Therefore, we only report on findings from the end-of-term survey in this paper.

The survey was given online, comprised of 41 items, and took students roughly 15 minutes to complete. All motivation and attitude items were measured on a 5-point Likert scale. There were 76 students in the Education course, and 63 completed the survey, for a response rate of 83%. There were 296 students in the Political Science course, and 176 completed the survey, for a response rate of 59%. It is possible that students who chose not to respond to the surveys were among the less motivated students in the class, but this was deemed a minor concern because the overall response rates were acceptable and we still had substantial variation represented in both groups in terms of motivation profiles (see Table 1 for descriptive statistics).

Course	Male/ Female (%)	Year in School (%)				MGO (%)	PA (%)	PV (%)
		Fr.	So.	Jr.	Sr.			
Education	73.8/26.2	4.9	19.7	11.5	63.9	52.5 (13.6)	53.2 (14.8)	58.3 (15)
Political Science	59/40	30.9	57.6	6.9	3.2	50 (16.9)	45 (14.2)	53.9 (14.4)

**Table 1: Student demographics and motivation profiles. Motivation profiles are reported as % of students scoring above the mean, and in parentheses % of students scoring 1 SD or higher than the mean, (e.g., 52.5% of students in the education class have a higher than mean Mastery Goal Orientation, and 13.6% are at 1SD or more above the mean).**

To measure student motivation, we used the Patterns of Adaptive Learning Scales (PALS; Midgley et al., 2000). These scales were developed to examine the relationship between the learning environment and students' motivation, including: personal achievement and goal orientations, perceptions of the teacher's goals, perceptions of goal structures in the classroom, and achievement-related beliefs, attitudes, and strategies. This instrument has been validated in multiple subject areas, and produces scales that indicate a respondent's mastery goal orientation (MGO), performance-approach orientation (PA), and performance-avoidance orientation (PV). Each of the scales used in the survey was highly reliable (EDUC MGO  $\alpha=.91$ , POLSCI MGO  $\alpha=.92$ ; EDUC PA  $\alpha=.80$ , POLSCI PA  $\alpha=.88$ ; EDUC PV  $\alpha=.73$ , POLSCI PV  $\alpha=.80$ ). Since each scale was internally reliable in our sample, we used principal component analysis to create a single component score for each of the three motivation orientations. These were then used in subsequent regression analyses (discussed below).

To measure student attitudes, we designed a series of questions about the course and the grading system, including a self-report of which assignments students planned to complete. The basic questions asked may be discerned from the summary data presented in Table 2.

## Findings

The first step in our analysis was to examine the data relating to student attitudes towards the class and the grading system. On the whole, students felt that they understood the grading systems, they generally believed that the grading systems were similar to video game systems, and generally believed that the grading systems both gave them more control over their course grades and encouraged them to work harder (in terms of choosing to do more assignments and work harder on their assignments). Finally, students generally *liked* the grading system in both courses, and found the courses personally interesting (all data is summarized in Table 2 below). We believe that the Education course and the Political Science course are contrastive cases with which to examine student motivation, and the data also supports this. A comparison of means on the items reported in Table 2 indicate that students in the two classes differed significantly from each other in terms of all items except for their understanding of the grading system. In all cases, the Education class was rated significantly higher than the Political Science course, though ratings in both classes trended positive. The one question on which students did not differ between courses was whether they felt they *understood* the grading system. Students in both courses indicated that they did understand the grading systems, to roughly the same degree.

	<b>Course</b>	<b>Mean</b>	<b>SD</b>	<b>t</b>
Did students feel that they understood the grading system?	POLSCI	4.05	.996	-1.236
	EDUC	4.23	.871	
Did students believe the grading system is similar to video games?	POLSCI	3.26	.977	-5.081**
	EDUC	3.98	.833	
Did students feel that it is easier to earn the grade that they want?	POLSCI	3.24	1.173	-5.003**
	EDUC	4.10	1.053	
Did students feel that the grading system provides more control over their grade?	POLSCI	3.50	1.207	-5.867**
	EDUC	4.48	.813	
Did students believe that the grading system encourages them to work harder?	POLSCI	2.67	1.210	-7.163**
	EDUC	3.93	1.056	
Did students choose to do more assignments?	POLSCI	2.44	1.225	-8.446**
	EDUC	3.97	1.119	
Did students find the class interesting?	POLSCI	3.75	1.016	-5.048**
	EDUC	4.48	.813	
Do students like the grading system?	POLSCI	3.28	1.212	-6.544**
	EDUC	4.40	.887	

POLSCI n = 167, EDUC n = 60, \*\* = p < .001

**Table 2: Descriptive data on student attitudes towards grading systems in each class.**

The next step in our analysis was to create regression models to investigate whether any of the motivation orientations (Mastery Goal Orientation (MGO), Performance-Approach (PA), Performance-Avoid (PV)) would serve as significant predictors of student attitudes towards the grading system. In particular, we focused on responses related to our three research questions as outcome variables: Do the grading systems help students feel more in control of their grades, lead students to complete more assignments, and encourage them to work harder? Our analyses did not reveal any significant relationships between the motivation orientations and student attitudes. This was surprising, as in other studies of student motivation in college courses, there is almost always such a relationship.

The final step in our analysis was to expand our regression models, by adding additional predictor variables that, in theory, ought to impact student motivation. Both student interest in the course ("interest") and whether or not students "liked" the course ("liking") were determined to be such items, and were thus included in additional models. Our final models for each of our three research questions have five predictor variables: MGO, PA, PV, "liking," and "interest."

For the Education class, the five-predictor model accounted for 35% of the variance in whether or not the grading system helped students feel more in control of their course grades ( $R^2 = .35$ ,  $F(5, 49) = 5.209$ ,  $p = .001$ ). However, the only significant predictor in this model was the extent to which students reported "liking" the course ( $\beta = .57$ ,  $p < .001$ ). We found a similar result for the Political Science course, with the model accounting for 46% of variance ( $R^2 = .46$ ,  $F(5, 150) = 25.03$ ,  $p < .001$ ), and liking the only significant predictor ( $\beta = .64$ ,  $p < .001$ ).

We observed similar results for the question of whether students felt that they would complete more assignments as a result of the grading system. In the Education class, the model accounted for 32% of the variance ( $R^2 = .32$ ,  $F(5, 48) = 4.485$ ,  $p = .002$ ), with "liking" as the only significant predictor ( $\beta = .53$ ,  $p < .001$ ). In Political Science, the model accounted for 25% of the variance ( $R^2 = .25$ ,  $F(5, 149) = 9.661$ ,  $p < .001$ ), but in this case *both* MGO ( $\beta = .26$ ,  $p = .013$ ) and "liking" ( $\beta = .28$ ,  $p = .001$ ) were significant predictors. This is the only case where one of the motivational orientations was statistically significant.

Finally, in relation to whether the grading system encouraged students to work harder in each course, the only significant predictor was, again, "liking." In Education, the model accounted for 32% of the variance (( $R^2 = .32$ ,  $F(5, 49) = 4.612$ ,  $p = .002$ ); "liking" ( $\beta = .58$ ,  $p < .001$ )), and in Political Science, the model accounted for 34% of the variance (( $R^2 = .34$ ,  $F(5, 150) = 16.116$ ,  $p < .001$ ); "liking" ( $\beta = .46$ ,  $p < .001$ )).

## **Discussion and Implications**

As noted above, we were surprised when the motivation orientations by themselves were not related to any of our outcome variables. This observation contradicts many years of scholarship in motivation. After conversation with colleagues who study student motivation, however, we have come to realize that this is an indication of the success of these two prototype game-inspired grading systems. In short, the grading systems might help re-focus students to an extent that they overcome typical motivational orientations. A student with a performance-avoid orientation, for example, might typically seek to avoid new challenges in order to avoid demonstrating incompetence. Yet, in these classes, students are more likely to take on new challenges regardless of how they would “normally” respond in a course with a more typical grading system. The only thing that appears to matter is how much students like the grading system, and to a lesser degree (not significant as a predictor but still present in our best models) the extent to which they are “interested” in the course. In one instance, for the Political Science course, MGO was a significant predictor of whether students completed more assignments, but this finding does not contravene our overall conclusions, since that is the motivational profile that one would most expect to predict effort. Indeed, its absence in all the other models is more surprising than its presence in one.

Having a grading system with the potential to trump student motivational profiles represents a powerful tool in one’s pedagogical arsenal. In both of these courses—one elective, one required; one mostly first-year students, one mostly upperclassmen—the instructors were able to create an assessment environment that encouraged students to work harder... and like it in the process. We recognize that assessment systems are only one element of the overall pedagogical design and implementation in these courses. Other factors, including course content, activity design, instructors’ manner, and so forth will also matter in terms of student attitudes and effort. But given the differences in these two courses, we are strongly encouraged to find similar results for both.

We also recognize that our data is based solely on students’ self-reports in our survey. While this is normal and unavoidable for the motivational profiling, we can do better in the future with respect to objective measures of effort. Future research will examine the actual work products students produced in each class. We also plan to link student course data to institutional data, allowing us to develop student profiles that include their performance in other university courses, their high school GPA, SAT and ACT scores, and a host of other factors that may be related to motivation and performance in college. However, given the general lack of quantifiable data on student motivation related to the design of game-inspired courses, we are pleased with our data and findings as a first step. Our research on motivation and effort is still early-stage. We hope to expand this research to include a far broader range of course content, and include comparison cases in our data that include more traditional grading systems.

The empirical research base for games and learning continues to grow rapidly. Building a strong base of evidence related to student motivation and learning is essential to convince critics of the potential in these approaches. And it is also important to acknowledge that there is no single approach, but rather a tremendous variety of ways that game-based and game-inspired thinking may transform the way we think about formal education.

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# A Systematic Review on the Potential of Motion-Based Gaming for Learning

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**Abstract:** With the inclusion of motion-based technologies such as the Wii-mote, Microsoft's Kinect or the PlayStation Move, the possibilities for using video games for serious purposes have multiplied. The purpose of this article is to explore the state of the research related to the use of video games employing motion-based technology for purposes other than entertainment. After systematically searching digital databases and online journals, 33 relevant articles were included in the study. We found that motion-based technologies have been beneficial when applied to physical and health education, training, therapy, and learning in the classroom, however, it has been noted that virtual environments might not be able to replace a real environment. Moreover, it is not clear in which situations these technologies can have a more substantial benefit. Overall there is a need for the proposal of new hypotheses and more in-depth research.

## Introduction

Studies show that traditional video games, meaning games which are mediated through a personal computer or console, provide engaging experiences that help users develop practical, cognitive, social, and decision-making skills (Foster & Mishra, 2009; Ma, Williams, Prejean, & Richard, 2007; Susi, Johannesson, & Backlund, 2007). Other studies indicate that playing video games can lead to aggressive behaviors and can be a factor in a number of potentially dangerous health issues such as obesity (Dipietro, Ferdig, Boyer, & Black, 2007; Foster & Mishra, 2009). Given that video games are often seen as having significant effects on players, it is not surprising that there is an increasing interest in the use of video games for non-entertainment purposes. Video games are used successfully in several fields such as in military training, health care training, and for instructional interventions in the classroom (L. A. Annetta, Murray, Laird, Bohr, & Park, 2006; Katrin Becker, 2010; Michael & Chen, 2006; Susi, et al., 2007).

Motion-based gaming, an activity in which players interact with a digital game environment primarily through physical movements and gestures in three-dimensional space, has added a new dimension to the gaming experience. Commercial devices such as Microsoft's Kinect for the Xbox 360 and Nintendo's Wii have opened up a number of opportunities for using video games for non-entertainment purposes. Through a systematic review we are aiming to answer the following research questions: What is the state of the research related to using motion-based gaming technologies for learning, and what are the opportunities, challenges and limitations when using motion-based gaming technologies for serious purposes as described in the literature?

## Methodology

This review was conducted over a period of 6 months. Articles were reviewed according to the type of research, research design, and the main topics representing current trends in the literature. Articles were retrieved from the following databases: EBSCO Host, ProQuest, Web of Science, Engineering Village, JSTOR and PubMed. The search strategy was tailored slightly for each database; however the common search query was: "video games" or "digital games" or "computer games" AND earning AND gestur\* or physi\* or haptic or wii or kinect or (motion and playstation). All articles were restricted to peer-reviewed scholarly publications ranging between the years 2005 and 2011.

In total, 112 articles were found. An initial review of the literature was conducted based on the title and the keywords of the author. Articles unrelated to the research questions, and those without an abstract were excluded. A second review of the remaining articles was done based on their abstracts. Similarly, unrelated articles were excluded. From the remaining set of results, a more detailed review was done; articles were included when the following conditions were fulfilled: (1) Articles must be related to the research questions; (2) The article should be fully available online; (3) Empirical articles should include enough information related to the type of research, research design and methodologies. Additionally, related articles from peer-reviewed journals in game studies such as Game Studies and Eludamos were added. As a result, we included a set of 33 articles.

In order to answer the first research question, the final set of articles were coded according to the type of research, goal of the article, results, limitations and future research, and type of technology described in the article. The type of research was classified into empirical and non-empirical. Empirical-research-based articles, which represent 62% of the articles that were included, were also coded according to the number of participants, type of participants and research design. Articles in this category were predominantly quantitative, representing 34% of the total number of articles. Even though qualitative articles represent just 6% of the articles, many articles combined both types of research. Articles with mixed methodology represent 21% of the articles. Non-empirical articles, which include literature reviews, descriptions of projects, and theoretical articles, represent 39% of the total. Without discarding the importance of these quantitative, mixed and non-empirical articles; it is evident that there is a need of more qualitative research. New hypotheses and more large-scale, comprehensive studies are also needed.

In addition, we also found that the most researched technology was the Nintendo Wii; commonly used games were *Wii Sports* and *Wii Fit*. Technologies that were moderately used were video-capture, dance pads, the Nintendo DS, and haptic gloves. These types of technologies have been more influential since the release of the Wii in 2006. Considering that this review ranges from 2005-2011, the popularity of the Wii is not surprising. Technologies such as Microsoft's Kinect or Playstation Move are relatively new and have been commercially successful, and it is expected that in the following years they will be the most widely researched.

In order to map out the opportunities, challenges, and limitations when using motion-based gaming technologies for serious purposes, we generated our own keywords (codes) for each article based on the abstract, goals and results. As a result, a list of 43 unique codes was generated. Afterwards, these codes were grouped into themes. We found two main themes: effects when introducing augmented movement to video games and application of motion-based games. For the first theme, 8 articles were included. These articles examined topics such as learning capacity and cognition, development of motor skills, social learning, and engagement and motivation. For the second theme—application of motion-based games—a total of 21 articles were considered, which were classified into: health/physical activities/sports, in the classroom, for entertainment, and for training.

## Results

Research regarding the effects when using video games with traditional controls show that video games can motivate players to continue gaming while developing cognitive, social and decision-making skills (Foster and Mishra, 2009). However, increased movement—one of the main characteristics of motion-based games—adds an extra dimension to the possible effects when playing video games. In this stream of the literature three topics that are researched are the relationship between adding augmented movement to video games and engagement, motivation, and learning.

Yannakakis et al. (2008) point out that there is a relationship between physical activity and engagement using video games. In a quantitative study, data was collected from physiological signals captured from 58 children from 8 to 10 years old when using two games developed especially for kids: Bug Smasher and an adapted version of Space Invaders. Kids interacted with the game while playing in a digital playground which captured the movement of the players. From the results, the authors demonstrate that when children are having “fun” during physical play they are engaged more; this was reflected through increased physical activity. In addition, Levac et al. (2010) conducted a study about the motivational effects when playing games that involve movement. Data was collected from 28 participants aged between 7 and 12 years while playing *Wii Fit*. Results show that movement in video games also contributes to motivating players to succeed in the game. However, results also indicate that there are differences between the quantity and quality of movement across different games, depending on the age and the experience of the participants. Children with previous experience using Wii demonstrate greater quantity of movement; however, there is no difference between the quality of movements.

In similar research, Dale et al. (2008) study the role of motor execution and longer-timescale cognitive processes, such as learning. The authors conducted two experiments exploring match-to-sample paired-associate learning, in which participants learned randomized pairs of unfamiliar symbols. During the experiments, their hand movements were continuously tracked using the Nintendo Wiimote. Both experiments showed that the dynamic characteristics of action reflect ongoing learning in a cognitive task. The first experiment showed that features of action dynamics grow more confident

over a learning task, and can mark the performance of the participant, indicating whether or not they had acquired particular knowledge. The second experiment revealed that these characteristics generally index learning, not just motor familiarity with the device.

From this section it is possible to conclude that integrating movement and games can motivate players to continue playing, engaging them in the activity, which can in turn foster learning across different tasks. However, most of these studies were conducted on children and using a limited number of video games. It is hard to generalize these results for all types of video games. However, these studies present evidence that there is a relationship between movement and engagement, motivation and learning with video games. This shows the potential of this type of technology when used for purposes beyond entertainment.

## **Applications in Physical and Health Education**

Most of the research that falls into this category supports the hypothesis that motion-based gaming can help to encourage players to engage in physical activities, promoting a healthier lifestyle. This technology can be integrated into a game specifically to promote physical activity or for entertainment purposes. Rhodes et al. (2009) evaluate the effect of videobike gaming versus traditional indoor cycling on the constructs of the theory of planned behavior, which studies the relation between attitudes and behavior, and adherence in sports. During the study, 32 male college students were instructed to exercise at moderate intensity for 30 minutes, three times per week, for 6 weeks. Results showed that affective attitude and adherence across the 6 weeks significantly favored the videobike condition over the comparison condition. However results might change if videobike gaming was to be compared to outdoor exercise. In a similar study, Warburton et al. (2007) reported that the attendance of the interactive video game group was significantly higher (78%) than that of the traditional training group (48%), resulting in a greater improvement in physical fitness. Both studies provide evidence of the positive impact when using these types of games for preventing obesity and motivating physical activity. However, other studies indicate that a virtual environment might not be able to replace a real environment. Baumeister et al. (2010) studied the difference between real and virtual environments through cortical analyses when individuals were playing golf. Overall participants performed with a significantly better score in the real condition. However, differences might arise if the experimental conditions are changed or if the experiment focuses on specific goals.

A common term for describing a way of combining physical activity and video gaming, often for entertainment purposes, is “exergaming.” A number of authors have suggested that exergames are appealing to children, adolescents, and young adults, and can motivate youth to increase their engagement in physical activity (Hicks and Higgins 2011; Papastergiou 2009; Paez 2008). Exergames also provide immediate feedback about the user’s performance. One of the most popular examples of this type of game is *Dance Dance Revolution* (DDR), which can be used to teach dance-related skills such as rhythm, tempo, and choreography, although Hicks et al. (2011) argue that the most important benefit is the potential to promote a healthier lifestyle. However, in 2008 Baranowski et al. conducted a literature review which found that studies involving DDR have reported mixed results, with some noting no change in physical fitness and a gradual loss of interest in the game among participants. Results from a series of studies that investigate the viability of DDR for increasing physical activity in the home environment indicate that both initial and sustained participation are influenced by a number of factors, including social interactions and the presence of other video games (Paez, 2008). Additional research is thus needed to explore the effects of these factors.

## **Applications in Training**

Motion-based gaming technologies have also been used successfully to train users in the use of other complex technologies such as surgical simulators or sophisticated haptic gloves systems. A study conducted by Boyle et al. (2011) investigates whether or not structured surgical training using the Nintendo Wii can improve the performance of laparoscopic tasks. Medical students with no prior laparoscopic or video game experience were divided into two groups. One group played four different games on the Wii, each of which required skills relevant to laparoscopic surgery, such as depth perception. The control group received no extra training. Results showed that all participants improved significantly from the first session to the second. While practice on the Wii was associated with a trend toward better performance, there were no significant differences between the groups for either the physical tasks (bead transfer and glove cutting) or the virtual laparoscopic tasks using the ProMIS surgical simulator.

Similarly, Bargerhuff et al. (2010) introduced a system that captures participants' perceptions when being trained to use a haptic glove system through a custom video game. There were a total of 5 participants, each of whom played for 60 minutes. A mixed methodology was followed and data sources included computer generated results (level attained, navigation speed, and efficiency), questionnaire responses (engagement perceptions), video-recordings, and detailed notes. Results suggest that the participants improved the skills associated with use of the haptic glove and active engagement with the game. Participants also demonstrated an ability to attain higher game levels with additional practice time, although this improvement varied among them. However, the study provided less evidence for the use of the haptic glove as an embodied skill. Participants continued to view the glove as a tool that required effort.

## **Applications in Therapy**

Another stream of the literature focuses on the use of motion-based technologies for therapeutical purposes for people with intellectual or physical disabilities and for the elderly. Through a literature review, Burstin and Brown (2010) explore the clinical applications of virtual reality technologies, and also discuss how consoles, such as the Nintendo Wii, can be integrated into different types of therapy and rehabilitation interventions. According to the authors, virtual reality technologies can raise the motivation level of patients performing repetitive rehabilitation tasks, and can be used to improve balance, posture, movements, and cognition through practicing different motor-learning tasks. Additionally, the authors point out that in contrast to some virtual reality systems, commercial gaming systems are relatively inexpensive and simple to set up, and may provide an effective alternative. However they may not be adequate for tracking patients' performance and cannot always adapt to the patients' abilities.

Regarding to the use of these type of technologies as therapeutical intervention for people with intellectual disabilities, Wang Y. et al. (2011) used Wii sports for supporting rehabilitation therapies for children with Down Syndrome. This quantitative study compares the effectiveness of using Wii Sports versus standard occupational therapies. Data was collected from 160 children with Down Syndrome aged between 7 and 12 years old. Participants used the assigned intervention on sessions of 1-2 hours, 2 days per week for 24 weeks. Results show that both therapies are effective in improving sensorimotor function as compared to children with no therapy; the virtual therapy improved motor proficiency, visual-integrative abilities, and sensory integrative functions for children with Down Syndrome; and there was an increase in motor, emotions and behavior skill subsets following both types of therapies.

In another study, Fenney and Lee (2010) probe the capacity of persons with dementia to learn motor tasks when using *Wii Sports* (bowling) as a recreational activity. Participants were 68, 79, and 90 years old males. Quantitative and qualitative data was gathered during 9 weeks followed by a 5-6 month retention test. Results present evidence that Wii environments are engaging. Participants improved and maintained performance for 5 months and completed motor tasks regardless of the conditions. Similarly, Yalon-Chamovitz (2008) studied the perceptions and effects of a video-capture game-based intervention for individuals with severe physical and intellectual disabilities when used as a leisure activity. Participants in this experiment were 33 young adults with a mean age of 28 years old. Data was collected using observations, and questionnaires. Participants were divided in two groups, the control group used traditional activities such as discussions and outings; participants in the experimental group used the virtual intervention. The activity took place for 12 weeks, 2 or 3 times per week, 30 minutes per session. Results show that even though there was a high interest in using the video game, participants were attracted to more active and physically demanding leisure activity and there were no changes in self-esteem.

Regarding to the use of motion-based video games for physical therapies, Bursting et al.'s (2010) literature review points to one of the main problems in physical therapies: patients receive a small amount of therapy time during rehabilitation. Virtual reality can deal with this problem providing assistance, immediate feedback, and real-time interactive experience. In this review, the author notes that through this type of therapy, patients tend to forget their limitations. Virtual reality encourages them to reach their goals and helps them to continue the therapy without feelings of fatigue or boredom. With the inclusion of new consoles, virtual reality can be cheap, and it is perceived by both patients and therapist as something positive. Additionally, in another study Eng et al. (2007) propose a motor neurorehabilitation system for stroke patients with upper limb paresis. The system is a custom application where the patient controls a first-person view of virtual arms in tasks varying from

simple tasks such as hitting objects to complex task such as grasping and moving objects. Usability results show that user acceptance of the system was high; most patients expressed a desire to use the system on an ongoing basis. Pilot study results show that therapy has not prevented patients' progress of disease, and suggest that it might add to the efficacy of traditional physiotherapy. Patients generally accept the therapy system and are motivated to use it. This system is promising for providing effective rehabilitation based on validated neuroscientific hypotheses. The system may provide improved efficacy of rehabilitation by enhancing patient concentration through the use of the goal-oriented tasks. Additionally, it can also be used as both a therapy and assessment tool. However, more work is needed in defining and calibrating standard tests using the game infrastructure to ensure reproducible results.

Lastly, motion-based technologies are also used as a therapeutical intervention for the elderly. De Bruin et al. (2010), in a literature review, have explored the potential of dance-pad-based training protocols for aged people. The main idea of this type of environment is to combine physical game-like exercises with sensory and cognitive challenges in a virtual environment. The most common reason for loss in functional capabilities in the aged is inactivity or immobility. Physical exercise helps to restore postural balance and walking function. However, physical exercise is sometimes challenging; people can be afraid or it can be painful. Gaming elements can be used to take patients attention away from any pain. Dance pads offer a potential alternative for training stepping ability in older adults, although it still is necessary to conduct further research in order to implement and evaluate virtual-reality based exercises. Results in an experiment conducted with older adult women showed that Wii-play did not have substantial physical effects, however, participants perceived an improved sense of physical, social and psychological wellbeing. Overall the experience was empowering and motivating for participants (Wollersheim et al., 2010).

## **Applications in the Classroom**

Research related to the uses of motion-based video games as a learning intervention in the classroom is scant. It is important to note that in this section we are not including physical education or sports courses, as they were included in previous sections. Yang et al. (2010) have developed a custom environment called the Physically Interactive Learning Environment (PILE), which is intended to integrate motion-capture technology into English as a second language classes at an elementary school level. The system allows students to carry out various English learning activities using physical movements and speech. Results from a study comparing the English abilities of a group using the PILE system to a group using traditional teaching using slides indicated that the PILE system had a beneficial effect on students' long-term learning. In addition, the system was easy to operate and enhanced the students' motivation to learn. These conclusions were based on observations of the students' behavior during the class, collecting data from pre-tests and post-tests, and through questionnaires and teacher interviews. Even though it seems that the PILE system is capable of attracting students' attention, the duration of the study, three weeks, one class per week, was insufficient to determine whether or not this effect would persist and for how long. Additionally, in a exploratory review, Maldonado (2010) explores the potential of using the Nintendo Wii in the classroom. The author concludes that even though the Wii may provide a number of benefits in areas such as vocabulary building, cognitive development, and participation, it is necessary to consider the following factors: there is a limited number of players that can participate at one time, movement is mostly focused on the arms and legs, loud sounds can be disruptive for children pursuing other activities, and cost.

## **Conclusions**

In the present work, we conducted a systematic review in order to explore the state of the research related to the use of video games employing motion-based technology for purposes other than entertainment. The research questions explored in this review were: What is the state of the research related to using motion-based gaming technologies for learning, and what are the opportunities, challenges and limitations when using motion-based gaming technologies for serious purposes as described in the literature?

For the first research question, we found that research has been rigorous in presenting empirical evidence that support the results. Most of the evidence relies on quantitative data and mixed methodologies. However, there is a need for more qualitative research in order to increase the depth of the research and propose new hypotheses. Additionally we found that, in the previous years, these technologies were expensive and were mostly in laboratories or other types of institutions. However,

now with the development and release of commercial devices such as the Wii and the PlayStation Move, costs have been reduced, and motion-based technologies are beginning to be introduced into more environments. The most researched technology at the moment is the Nintendo Wii, however, there is a trend to explore new console-based technologies such as Microsoft Kinect.

For the second research question, we found that, similar to other types of video games, motion-based video games motivate players to be immersed in the gaming experience while developing cognitive, social and decision-making skills. We also found that there is a connection between physical activity and engagement in video games fostering learning in different types of tasks, however a more precise definition of engagement would be helpful. Additionally, we found that motion-based technologies have been successfully applied in physical and health education, training, therapies, and in the classroom. Furthermore it has been noted that virtual environments might not be able to replace a real environment; there is no clear evidence as to whether these technologies can support a constant change in physical fitness or in which situations they can have a more substantial benefit.

As for future work, in order to achieve a deeper understanding of the potential of motion-based technologies for serious purposes, it is necessary to conduct more empirical research, create new hypotheses, and continue developing a deeper and more comprehensive understanding of the use of these technologies. Both types of research, quantitative and qualitative, could help to elicit different types of information that will be helpful in reaching more detailed conclusions.

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# **“Can I wait go to the hospital until after Math class?”**

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**Abstract:** *How can a math game initiate such a powerful change in perspective that students no longer choose to opt out of being attentive in math class?* Florida Virtual School asked the same question in July of 2011 and partnered with Imagine Education to find the answers. Using funds secured from the Next Generation Learning Challenge, FLVS and IE expanded and refined the existing story-based adventure game, *Ko's Journey*, and embarked on an ambitious pilot test in both the virtual and traditional 7<sup>th</sup> grade math classrooms. This revealing presentation will cover the basis of curriculum design and game integration as well as the results of attitudinal and performance data collected in during the eight-month pilot.

## **Overview**

A true story from Rio Gallinas, a public middle school, in rural New Mexico...

“A student broke his arm on the playground – I don’t mean a small break – it was a compound fracture. It was just kind of hanging there, so we had him call his parents to meet him at the hospital and he got on the phone...I was standing there, and he said, “Can you wait to go there at 10AM... after math class?”  
- Sean McLean, 7th Grade Math Teacher, one day after his students’ first experience with an Imagine Education math game.

Florida Virtual School has partnered with Imagine Education, creators of *Ko's Journey*, to pilot the use of story-based adventure gaming in middle math classes. The transformation in a student’s response to math class from “I hate math” to “Math class ROCKS” can happen almost immediately during engaging gameplay if it is implemented at just the right time and in right way. The quantified results reflecting this change—seen in four consecutive years of data collected on low-income minority students who showed an 80% gain in proficiency on state tests—are eclipsed only by a few thousand repeated requests echoed in a popular refrain of student enthusiasm, “Do we get to play the game today?” (Laidlaw, 2011)

Imagine Education (IE) is founded on the idea that through story, one of the oldest, most powerful architectures of human learning, educational games have the power to transform student attitudes, improve test scores and establish a foundation for future learning. *Ko's Journey*, IE’s first national on-line game release comes directly from the classroom. The concept behind the game was created by Dr. Scott Laidlaw, co-founder of IE and a teacher determined to engage students whose chances of succeeding in math were dismally low, not just because of a lack of prior knowledge, but because of the negative emotion they held for the subject. IE games are a revolution in learning, crafting every math problem so that it makes sense conceptually, and holds relevance, within the game mechanic and story.

The concept that math must make sense within the context of the game is a drastic departure from the majority of educational math computer games available, where an equation or exercise has been dropped into a traditional video game context. The add-on approach might encourage students to complete math drills—but it reinforces the lack of meaning and relevance math has in the mind of a student, particularly for students who are struggling with real-life challenges. It is not by accident that each and every pixel of *Ko's Journey* is unique. The story itself is of a human right of passage, not of monsters; the student takes on the role of a young girl in ancient wilderness, not a robotic avatar; and the math within the game invariably, absolutely, and always is transparent, not puzzling or hiding within the guise of an unrelated action.

## **Pilot Model**

Florida Virtual School and Imagine Education embarked on a challenging pilot project in the fall of 2011 to test the efficacy of *Ko's Journey* in the virtual school setting. FLVS integrated the game into the current M/J Math 2 course, typically taken by 7th grade students, by building an introduction module that preceded the normal course content. This is a diversion from previous in-course testing

of *Ko's Journey* where students were directed to go in and out of the game at various points throughout the course. The logic behind this design was to build a foundation for the core skills needed throughout the 7th grade course. Game play would be continuous for the first three weeks and then subsequent instruction in the course modules would reinforce concepts learned. FLVS worked with Imagine Education and John B. Cooney, Ph.D. of the University of Colorado, to conduct a comprehensive quantitative, and qualitative, research and assessment. Students were randomly assigned to both an experimental and control classroom for the FLVS six teachers involved in the study. Students were surveyed on interest level, technical skills, and math proficiency before the starting the game as well as a post-attitudinal survey after finishing the game module. A comparative pre-test and post-test were administered in the game platform to analyze learning gains. Results of this study are still being tabulated and are expected to be available in June of 2012. It is also important to note that while the FLVS pilot was underway, Imagine Education was conducting a parallel study in 20 classrooms in 10 traditional schools across the country using similar study criteria. FLVS is expecting to see increased student engagement, motivation, and performance from the students who began the course with the *Ko's Journey* module.

#### *Project Description*

The roots of *Ko's Journey* lie in a public middle school in rural New Mexico, where less than one-third of the classroom was proficient in math, and games where math made sense within a context-rich story resulted in immediate improvements. Bolstered by an initial climb in test scores when compared with peers beginning at the same level, the popularity of the games led them to become the primary component of the math curriculum. Studies evaluating the effectiveness of the in-classroom game showed impressive results; on comparing the New Mexico state average score (Standards Based Assessment in Mathematics, 5<sup>th</sup>-8<sup>th</sup> Grades) to the scores of students involved in IE's games (public schools) show a clear difference. The data are validated in that both groups of students began at the state average of approximately 28% level of proficiency. IE students involved in the games for two or more years showed a rate of proficiency more than double that of their New Mexico peers (n=91) (Laidlaw, 2011).

After a year of beta-testing a hybrid model between the large board game format and web-based software, IE began production of a fully web-based model of the most stable and engaging game architecture tested in the classroom and beta released this first-of-its-kind game in April 2010.

#### *Technical Features, User Experience & Common Core State Standards*

By presenting math within a rich and meaningful story context, we find that students of all abilities are able to stop asking "Why Math?" and start thinking about math, while engaging in repetitive, context-rich practice. *Ko's Journey* is a unique, first-of-its-kind attempt to use the newest pedagogy of video game technology as something more than animated flashcards or repetitive practice. Dr. Keith Devlin, author, Stanford Mathematician and leading researcher into educational math game technology, has recognized of *Ko's Journey* as an outstanding example of a "second generation math game" in recent presentations—taking us in the direction we must be headed if we are to capitalize on the true gains in learning that are theoretically possible with video game pedagogy, as outlined in his recent work (2011, 2012).

The central aspect of *Ko's Journey*, as a learning module, is a story-based game. Delivered via any common web browser through a blend of Ruby on Rails, Flex SDK and Adobe Flash, it is functional in over 90% of test cases on extant computers and netbooks used in schools throughout the US. Using an architecture called a "string of pearls" design, the game is played on individual machines. Students begin by logging onto their personal dashboard to take a multiple-choice pre-test and open-ended survey, which are saved and sent to the teacher dashboard. Next, students delve into the game through an introductory movie (as the game downloads behind the scene) that immerses students in the story of Ko, a young girl in ancient wilderness who must make her way back to her kin and a math module that teaches about the origin and use of degrees in a circle. Their first task is to set a compass to the proper degree and enter the correct number of steps Ko must take to "find" the next "clue."

Once "Ko", or rather the student role-playing her, "finds" the guidebook, the concept of the game truly begins. It is here that the heart of *Ko's Journey* is found, in an elegant game mechanic that allows students to progress using math in a highly functional and repetitive approach targeting critical areas of the Common Core State Standards (CCSS) for 7th grade math, and reiterates associated

background knowledge including the critical areas in 5th and 6th grade mathematics. Using continuously dynamic factors, students progress through the game and experience *Ko's Journey* by adding how much "they" are carrying in "stones", see how fast they can travel using a graph in the guidebook, determine their "biome velocity", multiply that speed by the number of "phases" they have left in the day, and then apply distance to scale. It starts with simple whole numbers and no adjustment for the biome then, as the student progresses, the challenge increases. Toward the end of the game, a student must add fractions with non-common denominators, read and comprehend a graph, take a percentage of a number, multiply that decimal by unique factors, and then apply that number to scale, all to make a single movement of Ko. The imbedded practice and assessment found throughout the game architecture is powerful. It is nearly impossible to not understand the basic concepts presented then put them into functional use.

As an endorsing partner of the CCSS initiative, IE created *Ko's Journey* to provide students with a focused, immersion-based learning experience for the following 7<sup>th</sup> grade math CCSS: (1) developing understanding of and applying proportional relationships; (2) developing understanding of operations with rational numbers and working with expressions and linear equations; and (3) solving problems involving scale drawings and informal geometric constructions, and working with two- and three-dimensional shapes to solve problems involving area, surface area, and volume. *Ko's Journey* also incorporates and reinforces CCSS for 5th and 6th grade math, including fractions; division using two-digit divisors; concepts of ratios and rates; and using expressions and equations. Throughout the course of the game, students encounter deep-learning concepts of critical thinking, collaboration and learning-to-learn. The numerous complexities within the game architecture provide opportunities for students to discuss and learn from one another about how to approach various problems, while limiting copying from one another or sharing simple answers.

In the game mechanic, there is one key feature that makes it all work, and creates the deep learning experience that really affects change for the students. Math is coherent in how it might be applied. This game mechanic is not just an add-on—it came from an actual 100-mile trek through the highest, most remote mountains in the Peruvian Andes, where a similar type of math was applied during climbing. The difference may seem subtle, but it is the key difference between a short-lived jump and long-term student growth. It is a believable mechanic for students because the game architecture is repetitive, simple, increasingly more difficult, and the math concepts are deeply learned with a growing emotional confidence. And because they make sense, the math concepts anchor.

The technical features for progress are intentionally simple. If the student enters an incorrect answer, they do not progress, but receive encouraging feedback to "try again", at which point they can re-enter the guidebook to review how to solve the problem. Teachers have reported that even students who are scoring well below their grade level on math assessments are still able to navigate, enjoy and learn from the game. Within the string of pearls design, as Ko travels, students encounter additional story-based modules that make sense within both the scope of the overall game and from an applied mathematical perspective. For example, early in the game, Ko must save a sick wolf pup by mixing medicines in specific ratios. Later along, she finds the North Star using Cartesian Coordinate mapping and a line equation. And, because she does find the North Star, she is able to travel at night, allowing for more travel time and distance to be gained, a major reward for students.

#### *Learning Improvement & Program Enhancement*

There is something else crucial to the architecture and concepts underlying *Ko's Journey* – it is not only what the students experience, but also what they do not. There are no arbitrary rewards such as points and awards. In our research, IE found that a point-based reward approach in math games encourages students to attempt to get done more quickly just to get the points, which leads to more mistakes and a lowered conceptual learning. A powerful finding of IE is that students (with the exception of summative assessments) work with more purpose when math is carefully embedded in a story. A teacher who recently used *Ko's Journey* in her Math Enhancement class was pleased to note that "Activities were repeated and scaffolded in complexity to drill the concepts, but in an interesting way through the student's engagement in the story, not rote memorization."

Stories, in narrative structures, provide a way to capture the complexity, specificity, and interconnectedness of an experience and conjoin them into coherent, meaningful, unified themes (Olson, 1990). Social scientists such as Bruner (1985) spoke of a narrative mode of thought and Sarbin (1986), who proposed story as a "root metaphor" for the study of human conduct, supported

an interpretive method that embraces the use of narrative. They contend that “story” provides a unit of meaning that stores and permits retrieval of the experience. Story provides an incredibly powerful means for learning, helping us store information in our memory for referral. In other words, *compelling story pedagogy takes learning deeper*.

With nearly a decade of experience of imbedding math and other textbook concepts within games, IE knows that skill at solving contextually-rich math does not always easily transfer over to skills in solving problems on a math test. Research has shown that math that is learned in any one context does not automatically transfer well to any other. Lave tested this with clothing tailors who were using a type of math, but could not then conduct the math in a textbook form. The reverse was also true; students who had mastered the math in textbook form could not apply it to the tailoring situation (Lave, 1988).

Thus, a critically important—and unique—feature of *Ko’s Journey* is a set of learning modules that first reference math concepts in the game, then reference the same concepts in a different but engaging context, and then finally provide practice of the concepts in a standardized test context. The technical architecture to support transfer of learning in *Ko’s Journey* also provides the basis for the imbedded student progress tracking. After students complete a module in the game on the Flash side (i.e.: the compass task), a “transfer of learning” lesson and quiz is triggered behind the scenes to be completed, and results are posted on the student and teacher dashboards.

Curriculum Specialists worked with educators and teams of college students (including minorities for modeling purposes) in a challenge format, to create additional engaging contexts for the same math concepts already seen in the game through dynamic videos that explicitly teach transfer of learning along with standardized assessments. In the enhanced Bridge Curriculum, students watch the videos via the student dashboard, take sample quizzes, and can use animated tutorials to improve their understanding of concepts. Through our existing architecture, scores and data are automatically sent to the teacher dashboard, along with formative, deep-thinking narrative responses completed by students. Another feature to be added is animation of the existing problem set images found in the game guidebook.

#### *Assessment Model*

There are six primary features that assess student learning in *Ko’s Journey*, creating a comprehensive overview of math proficiency, including: (1) progress in the game itself; (2) interactive problems sets; (3), a deep-thinking narrative response to video; (4) a pre-and-post multiple choice measure that will be developed as part of our research to assess students in CCSS; (5) multiple choice, short answer and narrative questions related to “bridge content;” and (6) a unique, pre-select format to enhance mathematical language. All features are fully integrated into the web-based game and provide automatic tracking for teachers.

The first aspect of assessment (in-game) is the most simple, and the most powerful: if a student answers a problem incorrectly, they do not progress. This is usually avoided by nearly all web-based curricula, for in the eyes of many developers, this architecture has a fatal flaw: “What if the student gets stuck?... They could be there forever.” As the goal is to create an autonomous process of learning, getting stuck means the end of the game, especially with the complex problem sets seen in a program like *Ko’s Journey*. However, for *Ko’s Journey*, this concept works. Because student engagement is higher, student effort to continue is higher. This small slice of cause and effect means that this type of assessment actually drives competency. During beta-tests, extremely low proficiency students (in the lowest 10% of their grade levels) continued playing *Ko’s Journey* and searched for solutions during recess breaks or lunch periods. If students did get “stuck”, they looked to the in-game guidebook to seek answers, and were successful in nearly all cases. Within *Ko’s Journey*, getting stuck provides an opportunity for deeper learning, as a student searches for answers and learns-to-learn. Like all aspects of *Ko’s Journey*, assessment of game progress is functional in that mechanics are conceptually accurate. For example, when a student sets the compass to the incorrect angle, instant feedback is provided as Ko then walks at the incorrect angle.

#### *Goal*

IE seeks to circumvent emotional resistance to math by providing students with an opportunity to create a relationship to math that is based on purpose and meaning. By introducing CCSS and exercises in a manner that makes sense within an engaging and complex story, students’ attitude –

and aptitude – in math is transformed. When the story-based learning is fully integrated into the classroom curriculum, teachers can then monitor their students' successes within the game and build upon this in the classroom to create a lasting impact.

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# The Role of Quantitative Assessment in *Just Press Play*: A Pervasive Game Addressing College Retention Issues and the Overall College Experience

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**Abstract:** American Colleges and Universities continually face retention issues, especially during students' freshman years; meanwhile, students often face less than ideal experiences transitioning to college life. Society at large endures the costs of low college freshman retention rates. *Just press play (JPP)*, a project being implemented at the Rochester Institute of Technology's (RIT) Interactive Games and Media School, aims to address these problems head-on through pervasive gaming, in which students are presented with opportunities to become integrated into the community, receive support, excel academically, and achieve a solid social, personal, and academic balance, all while having fun gaming. Research efforts focus on addressing how well the program is working, possible improvements, the nature and quality of the relationships between JPP, students, faculty, and the RIT community, and determining associations among variables that present opportunities to strengthen JPP's impact. Quantitative analyses focus on the JPP experience in regards to impact on student life and academics in addition to future considerations.

## The College Freshman Retention Dilemma

American colleges and universities graduate students from four-year degree programs at a rate approaching only about fifty percent of students admitted, a figure reported out as recently as August 2011 (Schneider & Yin, 2011). This is an alarming figure considering the ease of access and availability many students encounter through online and technologically enhanced courses, which often include Web-based support, discussion board forums, and plenty of links to additional resources for help. A (2011) report published by the American Institutes for Research calculated calamitous personal and national losses to total roughly \$158 billion forfeited in personal income and \$32 billion vanquished in federal income tax payments for one cohort of only freshman college students in just one year. These figures don't account for the devastating impact of state tax losses or for students outside this single, small cohort. It is noteworthy to mention that these figures were calculated during the recent national recession and account for high unemployment rates, which are often minimized in populations of those possessing undergraduate bachelor's degrees (Schneider & Yin, 2011). Furthermore, about half of college freshman leave their initial institution before beginning their sophomore year or drop out completely (Adams, 2011), illustrating the gravity of freshman retention efforts in the overall crusade to graduate educated students ready to enter the workforce.

Motivation, adjustment, and dispositional and academic optimism have been linked to freshman retention rates. Social, emotional, and academic adjustments are compelling experiences that deserve more attention in the higher education landscape (Nes, Evans, & Segerstrom, 2009). Meanwhile, while many colleges and universities have amped up their attempts toward retaining freshman students by implementing programs such as mandated freshman orientation courses, utilizing academic counselors to text students reminders of quizzes and exams, guiding students through the financial aid process, and providing counseling support to students, few programs have proven to be durable and reliable enough to deliver solid results (Adams, 2011).

## ***Just press play: a Solution to College Retention Problems***

This year, a ground-breaking initiative, *Just press play (JPP)*, funded by Microsoft and launching at the Rochester Institute of Technology's (RIT) School of Interactive Games and Media (IGM), will make a formidable, focused, and solidly-planned step toward addressing college freshman retention rates by implementing a project that specifically aims to tackle the difficulties freshman have when adjusting to their new college lives, socially, academically, and emotionally. Although RIT's School of IGM remarkably has a retention rate surpassing the national average for related programs, about 11% of RIT's IGM freshman cohort on average fail to return for a sophomore year of education in the program (<http://games.rit.edu/~thinkplay/a-vision-of-play>, 2011). In addition to the *JPP* program striving to confront freshman retention issues, administrators and faculty members at RIT

acknowledge that progressing into the games and computer industries can be troublesome even for students who do graduate from the program, and are confident that *JPP* will aid students in adopting healthy social, emotional, and work-related habits that liaise expertly with the professional landscape.

In the Interactive Games and Media [School], we have identified a series of “choke points” for our students; these are points where they must make significant changes in their understanding of the field and the quality of their work. It is a series of steps. It is a process of growth. In game terms, it is “leveling.” [*JPP*] aims to produce a proof-of-concept system that encourages student development through achievements and formative feedback. It conceives of the student experience as mirroring what Campbell (2003) has described as “the hero’s journey.” In that journey, not every element of the adventure is directly or immediately relevant to the overarching goal, or at least not in a way that is immediately evident to the protagonist. This is also true of the student experience; students struggle at times to understand how a given assignment, course, experience, or action relates to their educational and career goals. As educators, we strive to connect the dots between their curricular work and their professional goals. Faculty are their mentors in this journey; the Gandalfs to their Frodos. An achievement-based game system can encourage students to think of the “necessary obstacles” in their path as part of a coherent narrative of their learning and professional development. [*JPP* aims] to help our “student-heroes” determine what tools they need in order to successfully navigate those obstacles (their “academic dragons”) along the way. (*Just Press Play*, 2011)

Designers at the Rochester Institute of Technology’s IGM School have created a widespread game that bridges students’ academic, professional, and social lives using the *JPP* platform. Students in the Game Design and Development and New Media Interactive Development programs will have the opportunity to play through different quests en route to acquiring badges and achievements that will afford them chances to adjust to the college lifestyle, prepare for their future career goals, make new friends, find and network with people who have similar interests, and perform well academically, all while sanctioning feelings of growth, creativity, and ability in a supportive community. “[Thinking] of the “choke points” described [above] as the “level bosses” in our game, the goal of this system will be to allow students to better understand what skills they need in order to successfully defeat those bosses, and to encourage their engagement in activities that will build those skills” (*Just Press Play*, 2011). Furthermore, *JPP* will allow students to display their various talents and skills to friends, family, colleagues, and even to potential employers. In fact, students themselves will be encouraged to develop quests that they feel are inspiring and worthwhile (Lawley & Phelps, 2011).

As feeling socially isolated in a new place can be a challenging adjustment, *JPP* will focus heavily on collaborative and often fun activities, such as giving students the option to complete a quest that involves leaving campus to have dinner with a group of RIT friends, an activity faculty members at RIT have noticed happens rarely due to the nature and location of the campus. Other quests may entail activities like participating in a study group for the first programming course in a computer science sequence, going to say hello to a faculty member and locating a hidden object in their office (an undertaking freshman students are particularly thought to be shy about), visiting the career counseling office, stargazing with friends one night, or becoming involved with a sport at the recreation center. *JPP* seeks to afford opportunities for achieving balance in students’ social, personal, and academic lives, while making them feel as though they belong to a supportive community (Lawley & Phelps, 2011).

First and foremost, however, *JPP* does not aspire toward “pointsifying” the college experience in a cheap, commercial fashion. By evoking intrinsic rather than extrinsic rewards and focusing on valuable game design, *JPP* targets the exact principles that oppose the notion of pointsification, which inappropriately tries to capitalize on the mere and sometimes groundless presentation of points, badges, and scores as rewards in and of themselves. In the true sense of the ideas captured by the idea of successful *gamification* as being an experience inseparable from the spirit of a well-developed and fun game (McGonigal, 2011), “We intend for this game to take place online and in physical space. Students would play it in the classroom and the dining room, in shared spaces and alone in the confines of their head, on campus and off campus. The game will invite players to activate the spaces around them, encourage their interaction, and reward their engagement with the learning process...

The game will infuse their day-to-day experience with a real sense of play that reflects the playfulness of learning at its best, the (hero's) journey it can be" (*Just Press Play*, 2011).

*JPP* will be embedded in a wide array of RIT systems, including the RIT courseware system, library databases, co-op system site, and more. Hidden content (much like finding an extra, secret level in one's favorite video game) will be unveiled to students playing *JPP*, at which point they can decide whether or not to complete a discovered quest (Lawley & Phelps, 2011). Undoubtedly, this could become a game in and of itself and stimulate students to collaborate regarding their experiences with *JPP* with other students, who may want information about where hidden quests might be found. A parallel image of children leveling through a traditional video game, talking about it to their friends, visiting sites where information can be found, and most importantly having *fun* while being challenged is brought to mind.

From a technical standpoint, *JPP* will utilize card readers at various locations around campus that can essentially check students into a location where a quest activity may be. Privacy issues are a substantial consideration, and will be monitored carefully. Students will clearly know what type of information is recorded and to whom the information may be communicated to. Careful data management will need to reduce the likelihood of a security breach in addition to being minimally prying.

### **The Role of Quantitative Research in the Overall *JPP* Assessment Plan**

Due to the sensitive nature of the project, unbiased University of Wisconsin-Madison researchers will implement a substantial assessment and review that involves design recommendations for improving *JPP*. As part of a two-fold initiative involving both extensive qualitative and quantitative research goals, a mixed methods approach will be used to assess *JPP*. Quantitative research questions include addressing how well the program is working, how it can be improved, the nature and quality of the relationships between *JPP*, students, faculty, and the RIT community, and determining associations among variables that present opportunities to strengthen *JPP*'s impact.

Survey data and research conducted on data gathered through *JPP*'s infrastructure will be analyzed extensively. Both students and faculty members have participated, as faculty members' involvement with the project is critical for success, although the main quantitative analyses will focus on student data.

Variables of particular interest include the nature and quantity of badges/achievements awarded, the nature and quantity of quests undertaken but not completed, course enrollment and course-load information, participants' beliefs and attitudes about various aspects of *JPP* and RIT in general, students' academic and professional goals, and overall reported academic and community-related successes.

Determining which variables have a predictive and causal relationship in measuring the potential successes and failures of the program is critical and can lead to important modifications in the design of *JPP*. Determining whether or not there are significant differences in the outcomes among different groups while controlling for covariates in the model represent a gold standard in means-based testing and often provide key indicators that demonstrate strong differences among groups of data.

Finally, significant negative and positive correlations will be investigated at a more basic level, and relevant basic descriptive statistics and visuals will be divulged in order to provide important background information and a big-picture view of the research. Typical power and effect sizes will be reported out for all communicated and relevant findings.

### **Impact and Future Research Directions**

Benefits to participants in the *JPP* study are twofold: first, interviews with participants can serve as a vehicle for greater cognizance and reflection on the game on behalf of the individual participant, himself or herself. Secondly, participation may provide participants the opportunity to reflect on their uses of technology and to become more aware of the wide range of possible technology-related knowledge and skills that they already possess, thus potentially allowing them to view their game-related activities as academically beneficial and life-enhancing.

The results of the overall project can be of benefit to participants on a larger scale in recognizing the intellectual work involved with their participation with social media and digital technology. This could also help other universities who are thinking about implementing similar programs and allow them to build on the initial results of *JPP*.

Acknowledging that an initiative like *JPP* may have pervasive relevance to diverse educational and commercial settings, the goal of this research is to chronicle and divulge the design and developmental processes alongside research findings and *JPP*'s ultimate impact on the community. Determining best practices would prove useful to a host of different establishments.

Data collection and analysis is slated to conclude in June of 2012, and full research findings will be reported out and presented at this time. Follow-up measures at the end of the 2011-2012 RIT freshman academic year, as well as subsequent years present an interesting opportunity for research on longer-term impacts of *JPP*.

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## Hunting for Identity: Community, Performance, and the Curious Case of the “Huntard” in *World of Warcraft*

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**Abstract:** As we increasingly incorporate the virtual into everyday life, we open new spaces for exploration and encounter new (and very old) questions about the nature of identity: Where does identity come from? How do we engage with others in spaces where only a non-real representation is our source of identification? This paper argues for a re-thinking of our notions of identity grounded in the everyday world and proposes a more comprehensive set of definitions to encompass the expanded spaces of identity in the digital age. Using the online game *World of Warcraft* as a backdrop, I offer three key concepts to describe identity: that it is *performative* and relies on various states of being and actions; that it is *projected* both by individuals outward as well as by others onto an individual; and that it is *punctuated* by specific times and places and actions.

Identity is a vexing issue. It depends on people and perspective, on power and position, on performance and permanence. Yet when discussing identity, it is often treated as though it were a unified whole, a *thing* to be studied as-is, to be codified and crystalized into a specific description at the expense of all the various ways of asking: What am I? Who am I? How do I know? What do others know? What can I do? What can others do to me? This is further complicated when considering virtual spaces like videogames, where a medium sits between “me” and the world, and between “me” and others within that world. The interactions and transactions between the player, the world, and others is filtered by a shared metaphor (the game) and an inherent distance (the medium). Players must negotiate yet another layer of possible meanings to form an identity for themselves and for others, a pixelized persona that further complicates how we see ourselves and others, and how they in turn see us.

When discussing identity in all its manifestations, then, it is necessary to recognize that there is no *singular* identity, but a nexus of possible identities which includes how we think about ourselves, how others think about us, what we actually do, and when we actually do it. Each of these are a particular way of thinking about what identity *is*, from a functionalist view (“what are the actions taken”) to an ontological view (“what are the nature of the things involved”) to an epistemological view (“what do the actors know about and believe they are doing”). Each of these views are important at different times; we can call on a particular view to describe a particular feature of an identity. Considered together, however, they form a more complete understanding of identity in all its complexity. Indeed, together these features make up the ways we define ourselves and others, how we orient ourselves to the world, and how we act within it. Identity is a continuum of states that can be described in a number of ways; these various descriptions are useful when looking at different aspects of any identity but do not, in themselves, adequately describe an identity. Only collectively do we come closer to understanding the complexity of any given identity.

This understanding of “identity” relies heavily on a social constructivist view in that it assumes that our understanding of the world comes from our engagement with other actors, institutions, and constructs; it does not discount the individual experience, nor the “brute facts” of reality, but contends that meaning-making occurs primarily through our *social* interactions (Vygotsky, 1978; Searle, 1995; Latour, 2005; Kress, 2010). This observation is important for three reasons: it allows for an external reality in which we exist but do not have access to all information; it relies on an interpretive, experiential understanding of reality; and it assumes that this interpretation is filtered through both our previous experience and—more importantly—with the norms, customs, and institutions which exists outside of our control.

Further, identity also depends explicitly on the particular circumstances at any given moment, that the actors, objects, spaces, and relationships present determine that “version” of what an identity is. Some of these versions are more stable than others; being “American” is an identity that relies on numerous traits shared across time, while being an “ATM user” is more isolated and temporary. Some may be more dominant than others as well; again, being “American” entails a whole slew of customs,

expectations, behaviors, and beliefs, which influence being an “ATM user,” like expecting other users to stay a certain distance away while using the machine. The actions taken and the actors involved significantly influence how an individual defines themselves and how others define them. These contingencies—on time and place and relationships—help determine the identity of those involved. They also further suggest the variability of identity—who I am is really about *who I am right now*.

Given these assumptions, then, what can we say about identity? Partly that it's *performative*; that is, identity relies on the various states of being and the actions taken. Partly, we can say that identity is *projected*; an individual actor assumes a position and performs actions that they intend to be interpreted by others around them (an *outward projection*), and other actors both create and enforce expectations that influence the individual actor's choices (an *inward projection*). And partly, we can say that it is *punctuated*, that it depends on the specific contexts in which actors participate. These features are collectively a way of describing what identity involves.

It might prove useful, then, to examine specific examples of these features in action, how they are manifest in particular ways in particular spaces. Using the massively-multiplayer online game *World of Warcraft* as a lens to focus this analysis—and particularly comments from players of the game around the hunter class and the derogatory term “huntard”—I argue that identity is a socially constructed set of performative behaviors and beliefs that is context dependent and provisional.

### A brief history of the hunter class in *World of Warcraft*

I'll begin with a story, one not uncommon to players of *World of Warcraft* and certainly not unique to just the hunter class, but which highlights the sticky problem of identity—in all its forms—in action. Moxie was a new player of *WoW* (and whose name I've changed for this analysis), and chose to play as a hunter. She played through the introductory quests and leveled her character into the mid-20s; she explored the world and spent some time outside of the game on websites and forums reading about *WoW*; she even participated a little in the game's chat channels, asking questions and telling jokes. When she was invited to a group to play through a dungeon, she was excited and a bit nervous—this was her first chance to fight alongside friends and allies, and she was eager to show off her skills. The group entered the dungeon and then waited, for what Moxie didn't quite know. No one had made a move yet, so she decided she would try to kill the enemy first, to be the hero, to show how powerful she was, and how valuable to the group. She sent her pet in, waited a few seconds, and fired her own shots. She expected a quick kill—they had almost always been that way so far, after all—but it did not come. Instead, other nearby enemies noticed the commotion and joined the fray, swarming the allies and sending them scattering and shouting. In the chaos and confusion, she watched her companions die before being overwhelmed herself. As the dust settled, the recriminations began, chastising her, mocking her, calling her names: “huntard” they shouted, then kicked her from their group and far away into another place in the world, with wounded pride and little confidence, left wondering: what had happened? Why had her companions abandoned her? What had *she* done wrong?

To answer these questions, it's important to understand what the hunter class is and how it relates to other classes in *World of Warcraft*. A player of a particular class is expected to meet the roles that they are capable of performing; a hunter is a DPS-exclusive class, meaning that they are primarily responsible for providing damage to enemies. The hunter's role is primarily to provide enough damage to an enemy without interfering with the tank's responsibility (keeping the attention of the enemy, otherwise known as “holding threat”). Hunters have particular expectations about their behavior and performance that are assumed by other players in order to cooperate effectively. It is this set of expectations that can cause the kind of confusion Moxie experienced, and that is the heart of this analysis; namely, that she did not understand these expectations and “mis-performed” in her role as hunter, and the group identified her as a particular type of player and responded accordingly (and negatively).

Moxie's experience was not an isolated event, and indeed only happened because of a long history of the breakdown between a player's assumed or expected performance and their actual performance. Historically, hunters have been considered an easy class to play; because of the ease in playing the hunter class, they have attracted players who may not be familiar with the game or videogames in general. The result is that hunters were often “bad” at playing the game, and became stigmatized over time because of this mismatch in the assumed/expected performance and their actual poor play.

And so, as often happens in situations like this, others came up with derogatory terms for these hunters; inspired by the long history of the “retard” insult, *World of Warcraft* players began referring to these poor players as “huntards.” Along with this insult went a new assumption about what huntards were and what they did. They would break the rules (often unspoken) about what they were expected to do as hunters: they would take threat from the tank; leave their pets on aggressive (and subsequently engage enemies when the group may not be expecting it—Moxie’s particular sin); fight in melee range instead of at range, where they are far more effective; and (in)famously not pay attention to the fundamental mechanics or requirements of effective gameplay. While these kinds of breakdowns between the expected performance of a class and a player’s actual performance are not exclusive to hunters, they became most closely associated with the class and the term “huntard” became a quick way of identifying and labeling a bad player. As the game changed and other classes began to attract new or bad players, the “-tard” epithet was applied to them as well; in particular, the Death Knight class introduced with the *Wrath of the Lich King* expansion was often considered overpowered, and many players played the new class poorly. Unsurprisingly, these players were labeled “deathtards,” an homage to the huntard and evidence of the power of the original stigma of the bad hunter.

Nevertheless, it is important to recognize that the “huntard” identity did not spontaneously come into existence, but developed through a chain of interactions over time (even those that came from outside of the game itself, like the “retard” component). Further, because these interactions occur between various participants over time, players often have no control over what happens before them, and encounter a pre-formed expectation of what a huntard is and can do little to change this attitude. Moxie came to an environment that had highly ingrained social constructs, and she failed in navigating them and so was labeled a huntard. Even though she had never played with other players, let alone the particular group she joined, they already had a pre-formed way of identifying her, which stemmed from the long history of other (bad) hunters. Aware or not of this history, hunters face a particularly institutionalized set of assumed performances in the guise of the huntard that they must negotiate through their specific performance, and they may remain without control to directly confront this particular identity. It is this institutionalized identity of huntard that this analysis considers, whether justly deserved or not.

### **Performative identity**

The focus on performance in identity creation comes from a belief that doing and being are intimately related (Dourish, 2004). That is, the actions we take both reflect and create the sense of self and—more importantly—suggest that identity is not a static *thing* but rather a dynamic *way* of describing something. As Holland et al. (1998) argue, “[w]e are interested in identities, the imaginings of self in the worlds of action, as social products; indeed, we begin with the premise that identities are lived in and through activity and so must be conceptualized as they develop in social practice” (5). This approach suggests that not only are individuals acting in the world, but that others also act on and around the individual—indeed, that the world is experienced as a space for action; secondly, it establishes that the “worlds of action” that we exist within have a direct influence on *how* we choose to act. It is through our ability to act *and* be acted upon which helps us define who and what we are—in short, how we form an *identity*.

The second major reason for focusing on performance as a key component of identity creation is that it aligns closely with the space of this particular study, namely *World of Warcraft*. As a game, it is designed to be *played*, and this play consists primarily of acting upon and within the game world itself (though certainly not exclusively, as the plethora of WoW-related blogs, wikis, websites, forums, cosplay events, and a host of other activities demonstrates). In other words, it is a “world of action,” and one of a very specific type that can be delimited somewhat explicitly. Unlike the “real” world, *World of Warcraft* has a rather narrow set of explicit actions that can be taken as well as explicit limitations; whereas in the real world, the possible actions one can take are almost countless, *World of Warcraft* has a much smaller pool of actions and states a player can choose from.

A critical observation here is that these affordances and limitations in action are *intentionally designed* (Squire, 2006) by a specific entity, here Blizzard Entertainment, Inc. (hereafter referred to simply as Blizzard). Blizzard establishes the rules and systems that players use to play the game, and controls the implementation of these systems; they are the “gods” of the game, capable of changing the rules (and therefore the types of actions a player can take) at any time. Importantly, *World of Warcraft* is a “living” game in that it changes over time. Unlike a game like, say, *Final Fantasy VII*, which remains

essentially unchanged more than a decade after it was released, *World of Warcraft* has undergone thousands of major and minor changes since its initial release, from altering the design and shape of the world to adding and removing abilities to creating all new character classes. This iterative nature makes describing the game a bit of a moving target, and some things that are important at a given time may not exist at all in a later version of the game. For example, hunters recently received an ability that lets them launch traps which freeze or damage enemies; prior to this ability, hunters had to lay the trap directly at their feet. This change alters how hunters can perform—and in turn, how others expect them to. If nothing else, this iterative nature also supports the assumption that identity is provisional, as the game world can change such that a player literally *cannot* do something that was previously a key characteristic.

Because Blizzard designs the particular ways a player can act, they *prescribe* the ways identity can be formed; for if we assume that identity can be described by the types of actions an individual is capable of, then these defined limitations bound the potential actions, and therefore the potential ways of describing them. For instance, a hunter is given a wide range of offensive abilities, both ranged and melee; though highly inefficient at melee range, they *can* fight this way; so they *can* be called melee fighters. However, a hunter cannot heal (outside of very minor things like bandages and some small race-specific bonuses); they *cannot* be healers. The types of actions available to the hunter, then, define what they are capable of and, by extension, how they can be identified.

The flipside to this, of course, is that a player must actually *do* those actions in order to be identified that way, that they emerge from the performance of the player. Just because they are *capable* of an action does not mean it becomes manifest; they player must actually perform the action for it to be recognized (Gee, 2002). The game *allows* all hunters to extreme solo (fight high-level bosses by themselves), but not all hunters can or do. This is an important distinction in terms of identity, because identity creation depends not just on what a player can do, but what they *actually* do; it is enacted by players, and it is through this enactment of the afforded actions that they express themselves.

Here, it is interesting to note that some enactments are not explicitly endorsed or supported by the game's designers, Blizzard; rather, they provide a tool for players but it is up to them how to decide how to use it. For example, a common behavior for huntards was to use the in-game item distribution tool to try to get every piece of gear that dropped from an enemy, claiming that it would help them even if it actually wouldn't. The usage of the tool—and in this case, the *mis-use* of the tool—created a defining characteristic of the huntard identity. So identity does not rest solely on the actions *possible* in the world, but also on the actions *taken*. In this way, they serve as an institutional guide steering players towards certain “preferred” actions.

Nevertheless, players had enough freedom to not use these actions correctly, and their mis-performance (that is, their mis-alignment with the intentions of the designers, and therefore the other users of the world as well) gave rise to an alternative identity of the hunter which became the huntard, with all its various deviations from the preferred norm. Thus, performative identity relies both on prescribed and emergent actions; that is, what *can* you do as well as what *do* you do. The huntard identity came about because of all the things they did—and didn't do—within the world and with other players. The huntard was identified by their actions, by their attitudes, and by their performance of a set of loosely codified behaviors that deviated from the expectations of good play. By mis-aligning their play from the norms of other *WoW* players, they created a new identity that became the huntard.

### **Projective identity**

This mis-alignment highlights the potential for variation from what an individual sees themselves doing and being and what others see. Put another way, social actors can misrepresent, misinterpret, and misbehave with each other, and these misunderstandings come from the various perspectives of the participants. Even more directly, what one person thinks they are can be vastly different from what someone else thinks they are. Where do these variations come from? To start, it might be useful to think about them individually before considering how they align (or don't).

### **Outwardly projective identity**

An individual possesses some greater or lesser imagination about what they are, what they look like, what they do, what they believe in, and so on. When they act, they act with the belief that they *are* a specific person *doing* a specific thing; how they act is determined by what they want to accomplish and how they think it will best be realized. An individual actor assumes a position in which they *project*

*outwardly* what they believe they are and how they want to express it; this is a performative function (what I do) as well as a more conceptualized function (what I “say” about what I am, for example). When considering a videogame, which requires a mediative tool within the construct of a designed space, one way of describing this projection is in terms of the player’s relationship to their avatar (the most direct mediator in-game); Gee (2007) offers a description of this kind of “projective identity” (p. 70) as:

$$\text{virtual character (player surrogate)} \longleftrightarrow \text{character's goals + player's goals} \longleftrightarrow \text{virtual world}$$

This is an example of what I call *functional projection*; it describes a way of relating to the tools available (the avatar and its functionality), the things the game wants you to accomplish (what Gee calls the “character’s goals”), what the player wants to accomplish (the player’s goal) and the world, which provides the space and context for acting. In this sense, the functional projection serves as a way of understanding what a player wants to do and the way in which she can do them.

This model can also be adapted to describe the way a player relates to the other actors involved in and around the actions, what I call the *social projection*:

$$\text{afforded actions} \longleftrightarrow \text{societal goals + player's goals} \longleftrightarrow \text{social context/audience}$$

Here, this relationship describes the ways a player can act (afforded actions), what the other players want or expect (societal goals), what the player wants to do (player goals), and the space and actors, which define the context for the action (audience). In this way, a player thinks about what might be expected of her, how that compares to what she wants to do, and what means she has available to accomplish this. It also suggests that the player’s goals are always a compromise with what others want and expect.

A prime example of the outwardly projected identity is “mailbox camping.” A common practice in *World of Warcraft*, mailbox camping refers to highly/geared, “leet” players loitering around highly-populated areas of the world like the mailbox or the auction house, showing off their great gear and rare pets. What these players are doing, arguably, is projecting a display of mastery of the discourse, of verifiably high-level performance and superior abilities (Donath, 2007). What the player projects, or thinks they project, is uncertain, but it can be assumed that they are “showing off” how good they are and how much better they are than virtually any other player that might happen to pass by. However, what others see might vary significantly. Some may see the camper as a role-model of sorts, or something to aspire to; they can look at his gear and see how he has “built” his character through talents and equipment and use it as a template for their own performance. Others might, however, see it as a form of braggadocio or bravado, as pretentious or even disrespectful since he might linger for hours at a time near highly trafficked areas of the world showing off.

This division—what a camper thinks they are demonstrating and what other players think about them—is at the heart of the huntard identity; hunters rarely self-identify as a huntard and often think they are performing as a good hunter, while others may see something quite different. To better describe this potential division, I’ll turn my focus to these other actors and their influence on the individual.

### Inwardly projective identity

These other actors have preconceived notions of the world and others that they bring to any interaction. Often, the subject of their current attention may have little to do with these previous assumptions and may have little chance to contest or alter them, as was the case with Moxie. The individual at the center of their attention may have no access or even knowledge that they are being defined and identified.

The inwardly projective identity takes many forms. It is the source of identities like “American,” or “woman,” or “student.” These definitions rely on the support of the community at large, which positions the individual as a *subject* to the power of the community around them and on which this community influences the decisions made by the actor. These pressures can build such that they become normative, as in the case of “American,” to such an extent that they become universal expectations within the community, and the actor is expected to meet these criteria.

As a group of (presumably) more experienced players grouped with Moxie, they brought specific expectations of what constituted a “good” hunter. These expectations were forged through the institutions of both the game itself (Blizzard, as the designer who sets the rules) and the community of other players, who had developed normative assumptions about effective play. Unfortunately for Moxie, she was unaware of these expectations; indeed, the game had been training her to play one way (aggressively and at her own pace) and gave her little or no direct support for understanding the new conditions for her engagement with others. When Moxie mis-aligned her performance with the expectations for “ideal” hunter play within a group (she pulled threat and didn’t wait for the other players), the group had another set of performative expectations to call on and assign to her, that of the huntard. While Moxie had enacted some of the “huntard” characteristics inadvertently, the group assumed that was her “actual” identity and acted accordingly.

Moxie had, to that point, no direct access to the expectations that other players had for her; the group similarly had no interest in trying to express them. Here, the inwardly projective identity provided pressure (through fear of being shunned by others) to conform to the institutionalized expectations of the other players. As a result, Moxie changed her performative and outwardly projected identity, and has never been called huntard again. Moxie might have been a huntard with that first group, but she is not *universally* a huntard.

### Punctuated identity

This notion of temporary or provisional identity relies, of course, on understanding the world as a place in motion, that it is a dynamic space. Punctuation does not refer simply to temporal features (when did it happen), but rather to all of the circumstances of the “moment” including the actors, objects, spaces and other features of the world. In Moxie’s case, one group of players saw one instance of a player and positioned it as an example of a “huntard,” and took action accordingly. But subsequent groups of players that Moxie has played with have never identified her as a huntard, at least not overtly. Interestingly, she internalized the identity that was given to her (or, more accurately, that she co-created and was given a specific term for it by the group of players) and used it as a way of thinking about herself, but *only under certain circumstances*. That is, she recognizes that she can be a huntard at certain times because of certain behaviors, but that it is not who she is.

Some characteristics or identities, as noted above, can be more persistent than others. A player who makes a trade with another player takes on the short-lived identity of “seller” during the duration of the transaction (though she will always remain the “seller” of that object as long as it’s around and people *recognize her* as the seller). The same player maintains a stronger identity as “hunter” since she is locked into that role for the course of the game; she is even more strongly tied to the identity of “player” since her game play *requires* her to act; (arguably) nothing can happen to or by her without her “real life” interaction with the game, and so on.

Similarly, some identities are voluntary, or at least accepted; being a “seller” is a necessary state for a sale to occur, and the player is forced to assume this position, but likely does so readily in order to complete their intended goal (financial gain). Being a good player or “leet” is an aspirational identity that the player actively works to project. Being a huntard is likely not a voluntary identity (or even intentional), but one projected onto the player. And, as established above, some identities are unknown to those it is ascribed to; the actor may have no knowledge that they have been identified and described a certain way. In this case, it might seem that this identity is of no use since the actor has no access to it; however, this identity might still prove important since it can be tied to reputation (other players might talk about the hunter, for example, and decide they would never group with her going forward). Though the hunter has no knowledge of the effects of this identity, she is still affected by it.

Finally, identities can change over time, as is the case of Moxie. In her early play, she was often lost or confused, and her first group encounter (what she called her “huntard run”) represents one point in her overall progression. Now a level-capped player and raid leader, she no longer performs as a huntard or has that identity projected onto her; she is now a respected and expert hunter. Her fellow guildmates have witnessed this transformation, so she carries with her not just her current identity, but a history of change over time in her performance and her attitudes. Her identity is not static, but is a manifestation of all the various ways she has constantly re-created it. Importantly, however, this history is only apparent to those who recognize it as such and have access to her previous iterations.

### **Putting it all together and implications**

So here we have a real “chicken and egg” scenario: if identity is a situated instance of individually enacted (re)configuration of a socially constructed set of performative expectations based on actual, lived experience with the performance of these actions within a construct of afforded and limited actions, where does identity really come from? In the case of *World of Warcraft*, we might be able to say that it begins with Blizzard, the gods of the world who breathe life into a particular tool set that becomes “hunter” that players then inhabit. But even here, the outwardly projective identity comes into play because Blizzard does not prescribe the actual actions that help create and define the huntard. That comes from the players themselves, and the community of non-hunters who witness and label the behavior that propagates as huntard, and so the inwardly projective identity is in play too. Finally, it relies on a particular confluence of actors, events, and orientations and remains ephemeral and subjective, so any attempt to locate its source might be a futile endeavor by default. It may be enough, when trying to determine the source of an identity, to say that it is an emergent property of the individual and social actors in a particular time and place for a particular purpose and depends on the perspective of those doing the actual “defining.”

*World of Warcraft* provides a space where identity formation—for actors and communities alike—is mediated through the screen and is bounded by designed affordances, but the insights of the process and the ways it manifests applies to other social activities as well. Having a rich set of terms to use when analyzing interactions allows for more robust research and more nuanced descriptions of these interactions and in clarifying the particular focus of the research (on performance, on social situations, on interpretations, and so on). Simply being able to talk about *what part* of identity is being interrogated is a critical step towards better research. More abstractly—and more importantly—understanding that identity encompasses a range of factors and variables and is a continuum of states that all contribute simultaneously to defining any identity is a key requirement for engaging in the analysis of identity formation and practices. Finally, since identities are enacted in the everyday world in everyday situations, knowing the complexities involved in creating and maintaining any identity may foster more careful interactions with other social actors and more informed actions and assumptions.

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# Seeing Action: A Visual Analysis of *World of Warcraft*

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**Abstract:** Games are *meant* to be played. Most modern videogames, however, are complex spaces full of dynamic images and shifting goals; navigating these complex spaces is challenging for players as they must learn how to act in order to succeed. How do the designers of a videogame support players' learning and using the game? What resources can designers call upon to help players actually play the game? Using the massively-multiplayer game *World of Warcraft*, I contend that there are two primary visual methods designers use: the orientational structures of the interface itself and the interface's just-in-time/on-demand nature. Through these structures, the designers teach a player what and when information is salient in order for the player to take action and "do" the game as well as provide spaces for players to learn to master the game itself.

Interaction is, of course, a key feature of videogames. How a player controls certain events within the game world and how this world informs the choices made by the player are essential (if not uncontested) notions that help define videogames as a genre. Players use an interface—physical as well as conceptual—to influence the outcome of the afforded design of the game; and, depending on how previous actions affect the game world, the player then uses this interface to make additional choices, and the cycle repeats. What are these interfaces, and how do they make the game possible? As noted, they are both physical interfaces (keyboard and mouse or other controller, even the body itself) and conceptual (icons, buttons, cursors, and more complex visual representations as well as aural information and kinesthetic feedback). Game play requires both the physical and conceptual interfaces; however, this analysis focuses on the latter category and considers the manifestations of the on-screen interface to describe how players make sense of the world in which their actions take place.

This implies that videogames are designed texts and are created with particular affordances and limitations as a vehicle for the player to co-create and experience the game (Gee, 2007; Squire, 2006). Because a game is designed as an experiential space, the designer creates the text with the player's actual performance in mind; that is, the designer makes choices that help the player actually *play* the game. They may not create "complete" tools sets for users in order to provide some level of challenge (and, therefore, purpose) of the game. Nevertheless, the designer's intention is that the game will be played, and therefore creates a space in which a player can learn how to navigate within the world and perform the actions necessary to progress in the game.

Here, then, is another key element of games—that of *progression*. Progression refers to the notion that players work towards a goal, and that the game operates as a channel through which that work occurs; gameplay is a function of the change of states of the player through their interaction with the game. This implies that the player must transition from novice to master of the discourse of the game in order to make progress (Gee, 2007); it also implies that the designers must create a system through which players learn this discourse in order to master it. More specifically, game designers must utilize the interface as a resource to provide information for the player to make meaningful and then use to take action.

So, we can refine the question even further: what resources can designers use to support this progressively dynamic interface through which players interact with the game? Further, how do these structures support the progressive nature of gameplay, both in terms of moving through the game as well as in players' progressive understanding of the game and shifting from basic performance to high-level performance? Using the massively-multiplayer online game *World of Warcraft* as a lens to focus this analysis, I contend that there are two primary methods the designers of this particular game, Blizzard Entertainment, Inc. (hereafter referred to simply as Blizzard) use: the orientational structures of the interface itself and the interface's just-in-time/on-demand nature. Through these structures, the designers teach a player what and when information is salient in order for the player to take action and "do" the game as well as provide spaces for players to learn to master the game itself.

### Theoretical framework and methodology

I focus on two images (see Figures 1 and 2), which provide a strong sense of the dynamic nature of the gamespace of *World of Warcraft*. I have attempted to choose views and situations that players commonly encounter rather than looking for images that represent the extreme ends of a player's experience; however, the very shape and function of the game suggests that any images will show variation—sometimes profoundly. Figure 1 represents what might be considered the “standard” view when the player is at rest; they elements in this image (with some exceptions) are always present; similarly, Figure 2 is a “standard” view while in combat and grouped with other players and the elements in place here are normally present while in this state. Figures 1 and 2 can safely be assumed to represent the “normal” images players encounter when starting the game and when playing it at a high level.



Figure 1: The initial view of a new character at rest



Figure 2: High-level character in combat

For this analysis, I have adapted several theories outlined by Gunther Kress and Theo van Leeuwen's *Reading images: The grammar of visual design* (1996) and subsequent writings. In particular, their work on the composition of an image relates closely to an analysis of the player's relationship to their avatar, with the world around them and with their ability to act. Kress and van Leeuwen define composition as “the way in which the representational and interactive elements are made to relate to each other, the way they are integrated into a meaningful whole” (1996, p. 181). There are also significant “representational” and “interactive” elements that the designers use to create the interface of *World of Warcraft*, but to understand how the interface functions in such a dynamic space requires considering these parts collectively as well as individually.

Among the elements that align more closely with the study of a videogame, point-of-view, framing and salience are perhaps the most critical. For Kress and van Leeuwen, point-of-view describes position of the viewer in relation to the actors and objects within an image. Meaning for the viewer occurs in part by how they are situated to the “subjects” of the image; viewed from above, the viewer assumes

more power in relation to the “object” of their gaze, while the opposite holds true as well. Similarly, the distance at which this object is viewed helps determine the social relation between the viewer and the subject; an extreme close-up of a subject implies a close, socially-intimate relationship, while a character seen from far away is detached and remains a stranger to the viewer. Point-of-view is a key *socially relational* tool.

Framing is a relational tool as well, though less about the viewers’ relation to the subjects of the image than to the information conveyed. Framing refers both to visible frames (such as a box around an object, even the borders of the image itself) as well as invisible or implied frames (including objects aligned with each other). Further, I consider Kress and van Leeuwen’s notions of “given and new” and “real and ideal” (1996, p. 186-193) a particular kind of framing technique; while they consider the “given and new” and “real and ideal” as part of the “information value” of an image, I extend framing to include this informational value on a somewhat literal level—as part of the framed image placed in a particular spot. For Kress and van Leeuwen, the left/right and top/bottom orientation of the information in an image (and therefore, how it is framed within the confines of the image) provides an internalized narrative where the information on the left of the image is “presented as something the viewer already knows, as a familiar and agreed-upon point of departure for the message” (187), while information on the right of the image is “presented as something which is not yet known, or perhaps not yet agreed upon by the viewer, hence as something to which the viewer must pay special attention” (187). Similarly, top/bottom orientation provides information about the objects within an image and their status in relation to the viewer.

The third of Kress and van Leeuwen’s elements critical to this study is salience, or to what degree particular information is important in the image. Size, contrast, and location within the frame of the image all play a part in enhancing or minimizing the importance of a particular object; a large, centralized, strongly contrasted object appears more “noticeable”—and therefore more “important”—than a small object in a corner of the image that blends into its surroundings. Salience is also an informationally relational tool in a similar sense to framing; it helps the viewer discover what information might be important by highlighting it and drawing attention to it.

For the purpose of this analysis I have limited my focus primarily to the structural elements of an image; that is, the means through which designers attempt to convey meaning, not the meaning itself. This is not to suggest that I avoid the meaning of specific resources exactly; rather, I treat these “meanings” on a somewhat functional and generalized level. Not all icons mean the same thing, for example, and each conveys specific (and potentially unique) information. Further, I operate under the assumption that many of these tools are conventionalized within the genre of videogames and that users have a general understanding of these conventions, if not specifically within *World of Warcraft*. Together, these compositional elements create what I call *orientational structures* through which the designer helps to “orient” a viewer to the information the designer attempts to convey and provides tools to the viewer through which they can co-construct the meaning of the image.

Finally, it’s important to note that this analysis draws on my own experience as a player (and learner) of *World of Warcraft*. Having played videogames for much of my life, I am an experienced gamer, but I was new to WoW and the MMO genre; I assume my interactions in learning the interface was typical or average of most players. A more robust analysis would include player interviews or other qualitative/quantitative data collection to complicate or confirm this description. Nevertheless, I believe that many of the experiences I describe below are common enough to be meaningful.

### Orientational structures

To organize the specific orientational structures *World of Warcraft* employs, it is necessary to differentiate what kind of information is being conveyed and how before bringing it together to understand how this information is used by a player to play the game. In particular, how characters are oriented to their in-game representation (the avatar), the world around them, their abilities to act and with other “feedback data” each provide particular examples of the structures at work. Taken together, these structures support the other key function of the game, progression, which is covered in the later portion of the analysis.

### Player character

One of the clearest ways of visualizing the player-in-space is through point-of-view. Some games exclusively use a “through-the-eyes” or first-person view; the player does not see themselves at all,

but rather takes a position of looking at the world as if they themselves were in it. Other games provide a third-person view exclusively; still other games allow users to change their point-of-view; *World of Warcraft* falls into this latter category.

Figures 1 and 2 represent the default camera view of the game. There are other possible camera angles that a player can use, from an extremely far distance to a close-up of their character's face to a top-down view to a first-person view. Players can rotate 360 degrees horizontally around their character, and 180 degrees above their character down to ground level; they can also zoom from first-person out to about 50 yards away from the character. However—importantly, as we shall see—the camera always remains centered around the avatar. The camera, therefore, is a free-floating, user-controlled tool that occupies a half-spherical space of about 100 yards in diameter centered around the player's character.

Two key considerations take place in the player's relation to their avatar. First, they remain both detached and connected to their characters at all times (very few players use the first-person view as it is impractical for most tasks, which depend on high spatial awareness; third-person is the dominant view). Second, their character is always at the center of all actions that they witness in-game (again, discounting special circumstances like trade skills windows and cinematic cut-scenes). Both features play a significant role in orienting the player to themselves in the game and in learning to take action. However, identification with the avatar also depends on its position within the frame of the screen as well as the distance of the camera. That is, even zoomed out to the maximum distance, players are still centered on their character, so any exploration of the surrounding space is related directly to its relationship to the avatar itself. This centralization of the avatar enhances the identification potential of social distance by tying the world to the character regardless of the distance of the camera.

The centralization of the character plays another role as well. By tying the view of the avatar to the center of the screen and relating the rest of the world and other information to the avatar, the player learns to navigate the world through that character and to pay close attention to it; it becomes salient in that all action flows *through* the relationship of the viewer and avatar—all other information becomes important in relation to that centered view. As the in-game representation of the player, it is important to ensure that the player pays attention to the avatar; Blizzard utilizes a structure that puts the character at the heart of their every encounter with the world in order to emphasize its relative importance to the player.

### Game world

The avatar is only one way of relating to the game world itself; there is also the surrounding space in which the player acts (the environment) as well as other players, objects, and actors with which they interact. These objects and places not only “flesh out” the world, but provide a way to orient the player to their potential actions and to understand those actions and how they will in turn affect the player. It provides a “place” for the player to perform their actions. More literally, the world players navigate surrounds them completely in the figurative sense (they are “in” the world at all times) as well as a literal sense (they are always seen “in” the world in that it is ever present in the frame of the screen). The world fills the frame, and serves as a kind of “background” on which the player acts, as well as for other informational elements of the interface. The world is foundational in several ways; as a backdrop for action, it is a critical way to orient the player to *where* they are acting, which also influences how they act (they won't try walking through a brick wall, for example, or off the edge of a cliff); it is also foundational in a structural sense in that it provides the boundaries of the viewed world and the space on which all other information is projected. The world is thus both important (it's the context for action) and sublimated (it's a background). In terms of salience, the world can be both important (the player must pay attention to where they are acting in order to decide how to act) as well as less-important (much of the world can be “ignored,” such as the buildings in the distance, and the player can still function effectively).

The game world, however, isn't limited to just the territory of the game; it also includes objects and players with which the player interacts. Because *World of Warcraft* is a multiplayer game, the player exists within a world filled with other players playing synchronously. And because the space is a fully realized “world,” it is populated by objects for the player to use. Indeed, the bodies of the characters are not the most distinguishing feature of another player; instead, players have “nametags” above their heads that identify them and their affiliation to a guild. These objects and players also help orient

the player to the world by showing them what they can act on and who else might be involved. In this way, the world is more cohesively presented as a “real” space that the player can act within.

## Abilities

These actions take several forms: they are locomotive (the player moves from one place to another), they are interactive (clicking on an object), and they are more abstract (casting a spell or dealing damage). Figure 1 shows the initial screen a player encounters when first creating a character; along the bottom of the screen, a row of buttons appears which contain several icons—these icons are the “action potentials” a player can take. As players progress in the game, they gain more abilities, and the interface provides more space for additional icons (and, therefore, ways the player can act).

A player is presented with a large number of ways with which they can act in the world; however, it is important to note that these actions are contextual and cannot be used at all times—damage-dealing abilities like spells and attacks cannot be cast outside of combat (generally, though there are some exceptions), while some actions such as fishing or trade skills cannot be used while in combat. So even though the action-potentials appear at all times on the screen, they are not useable at all times. This notion will become more important in subsequent sections of this analysis, but here it is enough to acknowledge that the icons are ever-present but not ever-useable.

Also worth noting is that the interactive object for the player is split; it is primarily the avatar through which the player moves and acts with the world (the vehicle), but the player also uses a cursor to click on objects within the interface as well. This cursor changes shape depending on the potential action available, from using the in-game mail system to selling goods. This division of vehicle to drive the player and a separate interface object to perform specific actions sets up an interesting dynamic for the player. On the one hand, it separates them from fully embodying the avatar since they can manipulate the world via the cursor; however, it also serves to tie the interface objects such as the actions bars to the avatar, since clicking on an action button makes the avatar perform that specific task. The division of body from the action selection device (the cursor) is primarily a way to link the interface with the world itself.

The position of the action abilities also help the user focus on them; by placing them in the lower portion of the screen, they too serve a foundational role—they are at the heart of all the things that a player does in the game (with previously noted exceptions). Because they are central to the actual performance of the game (that is, in fighting of enemies), these actions appear in a portion of the space that is literally the base of the screen. Extending Kress and van Leewen’s notions of “real” and “ideal” frames, the actions available to the player, the “tools” to work on the world, are at the bottom of the screen, and represent the “real” world actions they can take, while the upper portion of the screen shows status-level information like player health. These status-level elements of the interface represent what the player ultimately wants to accomplish, while the action-potentials represent the specific means to do so.

## Data

The interface, however, also includes other elements beyond the action-potentials represented by the icons of the action bar, including player and target health, a mini-map in the upper right corner, a chat window in the low left portion of the screen, party-member health, real-time information like damage taken and dealt, and other information. Collectively, this data serves as additional orientation for the player by providing necessary information based on what they are doing. Some of this additional information appears automatically—combat text, for example, appears whenever the player is engaged in fighting an enemy. Some of this information is available at the player’s discretion and accessible through a keyboard button or other interface button such as the player’s inventory as well as more abstract concepts like player statistics (strength, agility, spirit, etc.). The player has access to both things with which to work (objects in their inventory) and the concepts through which they use these objects (their relative strength or their health pool, and therefore their ability to effectively wield a sword, for example).

Structurally, the interface elements are aligned within the frame of the screen in particular ways. These interface elements generally occupy the margins around the centralized avatar, and create a frame around the player which contains pertinent information. Combat text occurs within the space around the player on top of the game world and complicates this relationship, but I nevertheless consider it part of the frame around the character; the frame just has somewhat fuzzy boundaries.

Nevertheless, this frame reinforces the centralizing features of the avatar by tying all of the information around it.

The information within the frames takes on various levels of salience for the player. Again, since they are tied to the avatar by being placed around it, they can be assumed to be important and related to the status of the character. Since many of the elements of the interface are always present, they can again be assumed to be worth paying attention to since they likely provide information necessary to the player. By separating these elements from the background, the elements stand out and again can be assumed to contain valuable information for doing the game.

### **Orientation and progression**

So far, I have discussed the structures in place to help orient a player to the game world, and some of the ways that these structures emphasize certain information as important to the player. But what about one of the primary assumptions described at the beginning, that of “progression” through the game? Here, I mean progression both as moving from point to point (following the narrative of the game, for example, or gaining skills as the player gains levels), but also in terms of the player’s performance as they learn to master the space and their actions within it. How do these structures support this progression of the players’ interaction with the game? As players gain new abilities and experience more of the world, the interface changes to provide more information to them; further, as players experience the world and interact with it, they learn what information is important and when in order to act more effectively.

### **Capacities**

Capacities for the player include both action-potentials as well as conceptual information about the world and about themselves. As players progress in the game, they gain levels and abilities. Every other level or so, a player will have access to a new attack or healing ability. In a very literal sense, then, their ability to act has progressed from a few to numerous ways to act within the world. Similarly, there is a progression in the amount and type of things the player can interact with. The player, as they gain levels and progress through the game, gains more space to store objects as well as encounters a greater variety of types of objects (from equipment to trade skills materials like herbs and leather to quest-related objects and others). Not only has their ability to act increased, but the types of things they interact with and the spaces for those things have expanded as the player levels.

This notion of progression, however, is even more nuanced. In describing the player as gaining levels and abilities, I assume the position of the player; that is, I am referring to how the player progresses in the game. As they level, they gain abilities and objects to act through. However, from Blizzard’s point of view, progression works almost oppositely to the player’s perspective. Blizzard designs the game around the high-level abilities and content, and then must pare it down for new players. They create all the abilities and subsequently limit these abilities to certain thresholds. Rather than giving players new abilities, Blizzard eases the restrictions on a player as they level. This is an important, but somewhat tangential, observation that is nevertheless important to consider when thinking about the designer’s ability to provide meaningful structures for the player to learn the game.

### **Salience**

These meaningful structures, then, are put in place not only to support the players’ current actions, but to encourage them to learn how to use the interface in order to progress towards higher content. To do so, players must understand what information is important to them at a given time for a certain situation. We have already seen some ways in which information is made salient to the player, from the centralization of their avatar to the framing of the status information around them. However, salience also depends on this developing notion of progression in that players learn *what* information is important by *when* they encounter it in their gameplay. That is, the orientational structures of the interface provide clues to the salience of particular information only through the player’s evolving experience with it.

During the course of various gameplay experiences, a player’s focus may shift from different parts of the interface depending on what they are doing in a given moment. During combat, they may focus on their health bar, while during communicating with a group of other players their focus is likely on the in-game chat window. How does this shifting focus occur? How do players *know* when to seek out pertinent information? In short, how do players know what information is salient at any given time? Partly, the structures already described—centralization, framing, etc.—support the player’s learning

about when to call on information. The other part of the answer lies in the “just-in-time” and “on-demand” nature of the interface (Gee, 2003; Klopfer, 2008). That is, players are provided important and timely information when they need it which can be called upon by the player to make it meaningful. Further, this process is refined by continual use of the progressive nature of the interface.

By just-in-time, I mean that information is available to a player when they need it. In combat, for example, text appears displaying the damage they are taking and dealing. This information is not available out of combat since the player doesn't need to know that they are not doing damage. The game only displays that particular information when it *might* be useful to a player; it does not hide combat information and withhold information from the player. Similarly, the game does not present much unnecessary or superfluous information (within certain constraints). The interface is designed by Blizzard to provide information to the user when they need it in order to act.

However, just because the information is available to a player does not necessarily mean the player actually makes sense of it. Confronted with Figure 2, for example, a new player would likely be overwhelmed by the sheer amount and variety of information and not be able to actually play the game. Instead, the information presented must be available “on-demand” to the player. By this, I mean both literally (they can access it when they want to, such as opening their inventory or character pane) but also must be accessible to them *when it matters*. The latter is by far the more important feature, and perhaps at the very heart of gameplay, for understanding how to operate within the affordances and limitations of the game world *is* playing the game. In other words, knowing when to call upon the resources available to the player in order to act constitutes game play itself.

How players gain this understanding of when to call upon given information is supported both by the structures in place within the interface (the placement of objects, the framing of the screen, and so on) as well as with players continuous experience with that interface. As they progress in level, these encounters become more complicated, until they reach high-level content like that shown in Figure 2. By this time, they have encountered the various elements of the interface enough times to know when to call on the various elements. Through playing the game and using the interface repeatedly, players learn how and when to access the elements that are most important for their continued action within the game world.

### Conclusion and further study

In essence, then, the designers of *World of Warcraft* (Blizzard) utilize the orientational structures of the visual interface in order to teach players what information is salient and when in order for the player to take actions and *do* the game. These structures include the player's relation to their in-game representation and others within the world itself, as well as the way information is framed around the player to connect status-information and action-potentials to the character (and thus, the player's ability to act). But these structures also rely on the player's engagement with the elements of the interface over time, and the progression of both the player's capacities as well as their meta-level knowledge of the interface in order to perform at a high level. This high-level performance is the ultimate goal of Blizzard, and the structures they employ support a player's progression towards this goal. Understanding how players make sense of their actions constitutes the culmination of the design and presentation of a game. Players are *meant* to play the game; knowing how they come to this play capacity is central to the study of games and in the continued evolution of game play itself.

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# Dynamic Difficulty with Personality Influences

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**Abstract:** In this paper, we present a novel methodology to improve video game experiences by automatically adjusting video game difficulty based on both performance and personality traits. The Dynamic Difficulty with Personality Influences (DDPI) system generates a player's personality profile based on nine strategic questions. Using that profile and in-game performance data, DDPI customizes the game's difficulty level to create a player-centric gaming environment. Our experimental results successfully demonstrate improvements in both perceptual and actual gaming experiences. With our approach, traditional video games can be modified to provide personalized, player-centered gaming experiences.

## Objectives

In 2010, seventy-two percent of American households played video games (Entertainment Software Organization, 2011). According to the Entertainment Software Organization (2011), 82% of game players are 18 years of age or older, 29% of game players are over the age of 50 and 42% of all game players are women. With these changes to the gaming audience, game stories and genres have changed, but difficulty levels have remained generic.

Some studies have explored dynamic difficulty adjustment (DDA) using player performance data. Using key game characteristics, such as points or health, DDA algorithms make a decision to either maintain or change the video game's difficulty level. Unfortunately, these algorithms ignore the player's desired difficulty experience.

Other studies have explored profile-based systems using player personality attributes to create distinct, but similar, game environments. Typically, these systems restrict players to one static profile limiting the diversity of accommodated players and ignoring the player's skill level. Since skill levels increase over time, this system would have to re-classify players to continue increasing player experiences.

Profile-Based Adaptive Difficulty (PADS) is an algorithm that successfully combines profile-based and performance-based methodologies creating a player-centric system. Yun, et al. (2010) uses a player's experience level and difficulty preference to create a player into a single, pre-defined player profile. Based on Yee's (2006) work, an individual player should be able to subscribe to many profiles for the optimal player personality representation. Unlike static profiles, PADS uses performance data to customize the player's difficulty level. PADS measures a player's experience by the number of years they have played video games. Years of experience, however, are not a true indicator of a player's skill level.

We offer a different approach to profile-based and performance-based dynamic difficulty. Dynamic Difficulty with Personality Influences (DDPI) extends the core methodology of PADS. Instead of creating pre-defined player profiles, we define how particular personality characteristics influence video game difficulty. Using a player's personality characteristics, we generate a profile for each player to serve as a template for the player's difficulty levels. As the game progresses, we allow the player's skill level to further personalize the difficulty level. This methodology gives us a highly personalized approach while keeping the algorithm abstract enough to be applicable to several video game genres.

## Related Work

DDPI makes use of both player profiling and performance-based dynamic difficulty adjustment methodologies. Individually, both concepts are not new to the research community.

## Player Profiling

Bartle (1996) was the pioneer of player profiles studying the players of multi-user dungeons (MUD). He was able to divide the player population of this game genre into four distinct categories: Achievers,

Explorers, Socialisers, and Killers. These profiles were dependent on what each player hoped to gain from playing the MUD. Upon further exploration of these profiles, Bartle (1996) discusses examples of how players of each particular class behave, talk, and react similarly.

Yee (2006) surveyed players from MMORPGs. Unlike Bartle (1996), Yee (2006) believed an individual player can be partially committed to multiple profiles and therefore subscribe to different characteristics from each profile. He surveyed 3,000 players and discovered an overlap in profile characteristics.

In 2004, Lucas and Sherry (2004) studied motivating factors for video game players. Using focus groups, they have targeted six important characteristics that apply to most gaming genres: competition, challenge, social interaction, diversion, fantasy, and arousal. These player descriptions serve as the core of several post-2004 experiments, including ours.

Jansz and Tanis (2006) created a gaming focusing on eight key points: competition, challenge, social interaction, interest, entertainment, fantasy, pass-time (previously referred to as diversion), and arousal. They extended Lucas and Sherry's (2004) previous key points by adding interest and entertainment characteristics.

Schuurman, et al. (2008) had 2,895 players complete a five point Likert scale questionnaire over eleven subjects. Each question identified the degree in which that particular factor influenced the player's decision to play the video game. Following the self-subscription survey, they were able to use the post-analysis process to divide the players into four groups: overall convinced gamers, convinced competitive gamers, escapist gamers, pass-time gamers (Schuurman, De Moor, De Marez, & Van Looy, 2008).

## **Dynamic Difficulty Adjustment**

Dynamic Difficulty Adjustment (or DDA) was first introduced into the gaming literature in 2003 (Demasi & de O. Cruz, 2003). DDA tackles the issue of customizing video difficulty using a performance-based approach. There are several mathematical approaches to perform these tasks.

Andrade, et al. (2005) used a reinforcement learning technique (Q-learning) to detect player skills in a fighting game. Since reinforcement learning techniques require several iterations to learn enough to challenge a player, they use off-line bootstrapping to provide a starting point of difficulty. Then online learning is invoked to dynamically alter difficulty as the player progresses throughout the game.

Hunicke and Chapman (2004) developed a framework for DDA called Hamlet where a probabilistic method is used to determine when the player needs help. They suggest altering the game environment since the player is less likely to notice the change when compared to altering the player's character or the enemies.

## **Methodology**

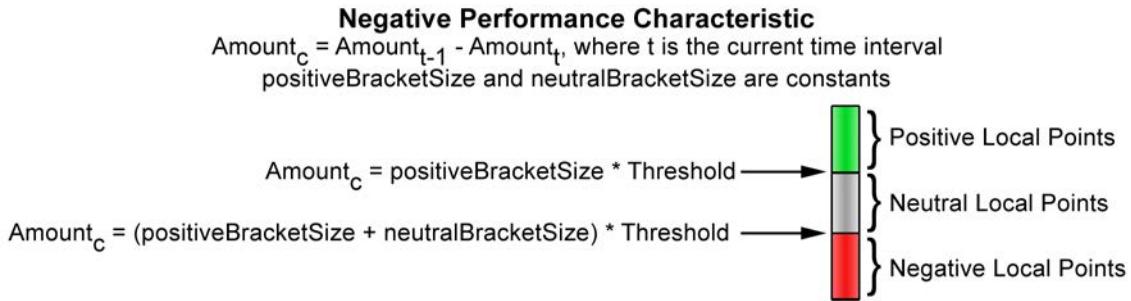
Dynamic Difficulty with Personality Influences (DDPI) contains three major components: performance characteristics, player profile and performance-based dynamic difficulty.

## **Performance Characteristics**

Each game genre has defining characteristics that game developers can use to determine the player's skill level, such as health points or overall score. DDPI uses these pre-defined characteristics as determining factors to adjust the game's difficulty. Each characteristic is paired with a threshold level, which is used to determine if a player has achieved good, normal, or poor performance in a single category.

There are two types of performance characteristics defined in DDPI: Negative and Positive. A negative performance characteristic expects the overall value to decrease over time. Figure 1 shows how DDPI uses a negative performance characteristic. Here we have three brackets or sections: positive, neutral, and negative. These brackets are represented as equal portions in Figure 1 but their size can be altered by the developer. If the change in value from the previous update interval falls in the Positive Local Points range, then this performance characteristic produces a value between 0 and 1. A positive value means this performance characteristic wants to increase the overall difficulty with a certain degree of confidence. If the change in value from the previous update interval falls in the

Neutral Local Points (or Local Points = 0) section, then this performance characteristic returns 0 signifying no difficulty change suggested. Finally, if the change in value from the previous update interval falls in the Negative local points range, this performance characteristic will return a value between 0 and -1 requesting for the overall difficulty to decrease with a particular degree of confidence.



**Figure 1: Performance Characteristic Graphic Representation**

Conversely, Positive characteristics are expected to grow over time, such as a game score. This type of performance characteristic behaves like the inverse of the Negative performance characteristic.

In a real game scenario, DDPI requires several performance characteristics allowing one characteristic to be balanced or negated by other characteristics. This provides DDPI with a holistic view of the player's performance providing more accurate adjustments.

## Player Profiles

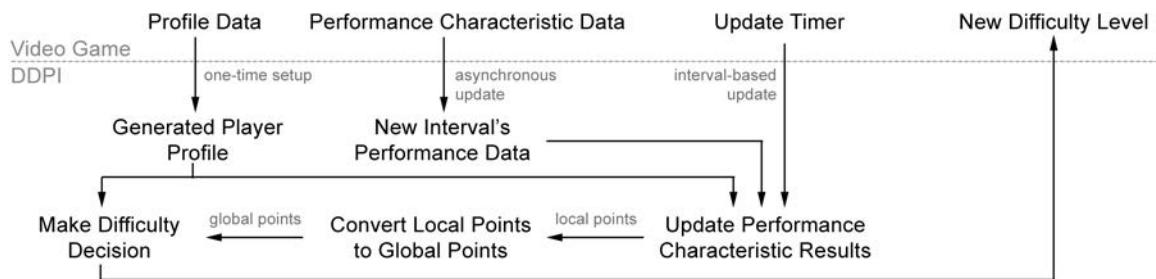
DDPI's player profiles are not pre-defined. Instead, we generate a new profile for each player based on a pre-defined set of personality traits. Each personality trait allows DDPI to alter the threshold levels and bracket sizes for specific performance characteristics. DDPI also uses personality traits to create a minimum, maximum, and starting difficulty level. This range of difficulty serves as a check system to limit the in-game DDA difficulty levels.

## In-Game Dynamic Difficulty Adjustment

Once player profiles create base guidelines for the player, the game can be further personalized based on the player's performance. DDPI's dynamic difficulty adjustment (DDA) system relies on the developer's performance characteristics to make decisions about difficulty. Since these characteristics are defined by the developers for a particular game, DDPI is applicable to several game genres. By adding all of the performance characteristics together, it becomes possible to calculate a final global score. If the global score is greater than or equal to 1, DDPI increases difficulty. Conversely, if the global score is less than or equal to -1, DDPI decreases difficulty. Otherwise, the difficulty level remains the same.

## Overall DDPI System

Both the profile-based and performance-based components are interdependent to create a holistic approach to dynamic difficulty. Figure 2 depicts the overall system:



**Figure 2: DDPI's Overall Workflow**

First, DDPI generates a player profile based on the data acquired by the video game. This data includes performance characteristics (thresholds and bracket sizes), starting difficulty, minimum difficulty, and maximum difficulty. Since this data varies for every game, DDPI requires game developers to choose accurate parameters. After setup, the player starts to interact directly with the game. When events relating to the performance characteristics update in the video game, DDPI should be notified of changes. As time progresses, the game's update timer will indicate that DDPI needs to update the difficulty level. This update interval can be fine-tuned to any value. Using the player's profile and performance data, DDPI creates local points (bound between -1 and +1) from the positive and negative performance characteristic algorithm. The local points are then aggregated to create a single global point value. Using the player profile, DDPI then selects one of three choices: raise, lower, or maintain the current difficulty level. Finally, DDPI returns the selection to the game modifying the player-centric gaming environment.

## Experimental Design

Our experiment is based on a generic platformer genre video game. The participant controls an adventure seeker exploring a fictional civilization's ruins. The game's goal is to reach the end of each level without losing all of the player's health points.

Our implementation of the game features nine levels of difficulty (1 being the easiest, 9 being the hardest). While several game parameters can be modified to control the game's difficulty, not all are good candidates for variability. Hunicke (2004) states that successful DDA systems must maintain a game's internal balance and feedback mechanisms so drastic change between difficulty levels would be distracting to a player. Bailey & Katchabaw (2005) wrote about adjusting non-player character attributes to increase or decrease the difficulty of video games. We chose to alter items out of the player's control so difficulty changes are not as easily noticeable. Our platformer game has four different types of enemies featuring their own pre-set attack points, health points, and movement speeds. By changing the game's difficulty level, the enemies either increase or decrease their attack points, health points and movement velocity based on pre-determined values.

Our study consisted of 31 participants. We had 25 males and 9 females between the ages 12 and 31 (Average = 23.10, S.D = 3.67). Each participant sat in a chair in front of a Windows-based laptop with a 15 inch screen and was provided with an Xbox 360 controller to interact with the game.

Before the trials started, we explained how to play the game to each participant using screenshots and answering any questions they might have. They then were required to fill out a brief demographic survey and personality questionnaire. The questionnaire asked nine questions:

1. Do you want to play video games to be the best player in the game?
2. Do you play video games to challenge yourself?
3. Do you play video games to share an experience with others?
4. Do you play video games since they let you compete against others?
5. Do you play video games when you are bored?
6. Do you play video games to do things in games that are too challenging or impossible in real life?
7. Do you play video games because games offer exciting challenges?
8. Do you play video games because you enjoy difficult games?
9. How often do you play video games?

The first eight questions targeted particular personality traits, respectively:

1. Competition Enjoyment
2. Challenge Enjoyment
3. Social Interaction
4. Social Interaction
5. Diversion
6. Fantasy Interests
7. Arousal/Excitement
8. Entertainment

Each of the questions had the following choices: Strongly Agree, Agree, Disagree, Strongly Disagree. Using this information, we dynamically created a player profile for the participant. The final question was added after a preliminary focus group study. We found that the amount of exposure or

experience with video games had an effect on the participant's skill levels and must be considered when creating a minimum and maximum difficulty level setting. The answer choices for this question were: "I rarely play games", "I don't play games often, but I have played on occasion for years", "I play games at least once a month", "I play games at least once a week."

After completing the survey, we allowed the participants to play a practice trial. The trial was set to the Easy difficult level (Difficulty Level 3). Since we were interested in how the participants felt during game play, we displayed a two question survey questionnaire every minute. The questions were loosely inspired by the Microsoft TRUE design (Kim, et al., 2008):

1. Are you currently enjoying the game?
  - a. Yes
  - b. No
2. Would you like the game to:
  - a. Be More Difficult
  - b. Maintain the Current Difficulty
  - c. Be Less Difficult

The first question asked about the participant's perceived enjoyment factor. The second question asked about the participant's perceived difficulty desires.

After the practice trial, each participant played four additional trials. Each trial featured a different difficulty mode: Static Easy (Difficulty Level 2), Static Moderate (Difficulty Level 5), Static Hard (Difficulty Level 8), and DDPI. We counter-balanced the trial order so not all participants had the same exact trial order. Each trial was ten minutes long allowing ten in-game perception surveys to be displayed. After the tenth survey, the game would exit allowing the participant to relax until the next trial. After the final trial, we asked participants to complete a post-game survey. They ranked the trials from their favorite to least favorite. We also asked them to rank the overall difficulty of the DDPI trial (without the participant being aware of DDPI) on a scale between 1 and 4 where 1 was enjoyable and 4 was not enjoyable.

## Results and Discussion

We observed how well DDPI improved the participants' gaming experiences by analyzing the in-game and post-game survey data. First, we collected the participants' survey information. We analyzed how DDPI categorized each participant based on this survey information. Next, we analyzed the in-game perception survey responses for all four trials. For each minute, we also recorded how DDPI adjusted difficulty during the DDPI trial. Finally, we recorded the post-game survey results.

Of the 31 participants, 25 were male and 6 were female ranging from 12 to 31 years of age (Average: 23.10, S.D: 3.67). Table 1 shows how the participants responded to our pre-game personality trait questionnaire.

Question characteristic	Strongly agree	Agree	Disagree	Strongly disagree	Overall agree	Overall disagree
1. Competition Enjoyment	3	16	10	2	19	12
2. Challenge Enjoyment	4	23	3	1	27	4
3. Social Interaction	10	14	6	1	24	7
4. Social Interaction	5	17	7	2	22	9
5. Diversion	16	9	5	1	25	6
6. Fantasy Interests	8	13	7	3	21	10
7. Arousal/Excitement	8	21	2	0	29	2
8. Entertainment	7	20	2	2	27	4

**Table 1: Personality Characteristics as defined by our participant set**

The majority of our participants categorized themselves as they (1) enjoyed challenges, (2) played games to alleviate boredom, (3) were entertained with games, and (4) were excited overall by playing games. Very few of our participants disagree that video games entertained or excited them.

In order to determine if DDPI improved the participant's gaming experience, we asked each participant to rank their most enjoyable (favorite) trials at the end of the final trial. DDPI was ranked most favorable 10 times, second favorable 9 times, third favorable 6 times, and least favorable 6 times.

Using the participant's post-experiment perception of the trials does not give us a full picture of the whether DDPI improved player experiences. Every minute we asked the participant if they were enjoying the video game. By using this in-game survey, we found that DDPI was either the most enjoyable or tied for the most enjoyable experience for 16 participants who did not pick DDPI's trial as first. Based on in-game survey data, combined with post-game preferences, we conclude that 26 out of 31 participants favored the DDPI-based trial.

In addition to improving the player's entertainment factor, DDPI's goal is to correctly adjust difficulty for the player so the video game is not too difficult or too easy at any given time. In the in-game, minute-by-minute survey, we asked the participants if they would like the difficulty to be easier, harder, or unchanged. Based on our survey, the optimal difficulty level is when the participant replies "maintain difficulty." This implies the game is not too hard or easy for the participant at that particular point in time. Table 4 showcases the minute-by-minute results for each trial:

Trial	More difficult	Less difficult	Maintain difficulty
Easy	92	34	185
Moderate	68	53	189
Difficult	61	61	188
DDPI	61	35	214

**Table 2: In-game responses for difficulty adjustment by Trial**

DDPI optimally adjusted the difficulty for 69.03% of time played while the moderate, difficult, and easy modes optimally adjusted difficulty levels for 60.97%, 60.64%, and 59.69% of the time played, respectively. Therefore, DDPI had the highest percentage of desired difficulty for the participants.

In addition, we observed the relationship between the participant's gaming experience level and DDPI's difficulty adjustment. In our pre-game survey, we asked participants to classify how often they played video games. For participants who rarely play video games, DDPI mode was accurate for 77.50% of the time. For those who occasionally play video games, DDPI mode was accurate 85.00% of the time. For those who play games at least once a month, DDPI mode was accurate 85.00% of the time. Finally, for those who play games at least once a week, DDPI mode was accurate 51.54% of the time. It is important to note that 22.74% of all participant surveys asked for the game to be more difficult and only 14.76% of the in-game surveys asked for the difficulty to be decreased. However, for participants who play video games at least once a week requested the video game difficulty to increase 37.88% of the time. This indicates that our sample game did not have a high enough difficulty level to challenge the most skilled participants.

## Conclusions and Future Work

Overall, our algorithm successfully increased the participant's gaming experience. Based on post-game surveys alone, DDPI was ranked as the most enjoyable trial 32.26% of the time making it the most favorite trial among all participants. Considering in-game enjoyment data from those who did not select DDPI as their favorite trial increases the enjoyment factor to 83.87%.

In addition to improving the player's entertainment factor, DDPI selected difficulty levels that were ideal for the participant 69.03% of the time. The closest performing static trial created an ideal difficulty environment 60.97% of the time. DDPI offers an 8.06% increase in optimal difficulty levels. Increasing the overall difficulty and optimizing the thresholds of our testing video game would further increase this spread.

Since each individual game requires the setting of performance characteristics and starting thresholds, we could improve our results by having a larger testing focus group before the

experiment. Using this information, we will be able to make adjustments to increase the effectiveness of DDPI.

In the future, we will expand the experiment by conducting an additional survey after each trial. The post-game survey will ask the participants how they perceived the trial's difficulty. Using this information, we will have a better understanding of how the participants really perceived difficulty after each trial instead of waiting until all trials were completed.

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# 'Just Do What I Do': Imitation and Adaptation in *Kinectimals*

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**Abstract:** Motion-based console games are videogames that are played primarily using gestures and other forms of kinaesthetic input, and include games for Nintendo's Wii and Microsoft's Kinect. This pilot study sought to investigate how Kinect's hands-free system trains players to interact with its interface, and if and how players improve, looking specifically at the virtual pet game *Kinectimals* (Frontier Developments, 2010) for the Xbox 360. The observations gathered during the study suggest that the game involves a period of adaptation in which players continuously adjust their movements in relation to perceived affordances and constraints. Focusing on situations in which participants seemed to have difficulty interacting with the system, this paper argues that while *Kinectimals* might not be useful for teaching specific, transferable skills such as accurate throwing techniques, it may have the potential to improve players' general ability to imitate and adapt physical gestures.

## Introduction

Kinect is a motion sensing peripheral developed by Microsoft for the Xbox 360 videogame console. The device incorporates computer vision and voice recognition technologies, allowing users to interact with the system through gestures and speech, without the need for a physical controller (Gates, 2011). Kinect is considered to be a "natural user interface" (NUI), meaning that the modes of communication used to interact with the technology approach the ways in which human beings communicate in general (Gates, 2011). NUIs are designed to be intuitive and should require very little learning on the part of the user in order to operate effectively (Kratky, 2011).

One of the launch titles (games released concurrently with the device) for Kinect was *Kinectimals*, a virtual pet game developed by Frontier Developments (2010). While the Entertainment Software Rating Board (ESRB) has rated the game for all ages, it is designed specifically for young children. In the game, players interact with a group of animals referred to as the cubs, each of which is based on a different species of wild cat. The game consists of a number of activities such as teaching tricks to your cub, throwing and kicking balls, driving a remote control car, and guiding your cub around an obstacle course. Timed competitions are interspersed with periods of freeform play, and the player is encouraged to accumulate "discovery points" in order to unlock new areas as well as objects such as toys, collars, food, and other amenities.

Many of these objects can be used during play, and require the player to perform different gestures that loosely approximate how they would interact with the object in real life (for example, tossing and kicking a soccer ball). As the player plays with their cub, different challenges appear on-screen, which the player can complete for points. Whenever a new activity is introduced a virtual guide in the corner of the screen, who introduces himself as Bumble, explains what to do and demonstrates the action below written instructions. This anthropomorphic guide is indicative of the limited capacity of Kinect to detect and recognize gestures, and the resulting necessity of teaching players, through tutorials or by other available means, what movements to perform. If a player's movements do not correspond to some degree to the gestural pattern being demonstrated, the system often responds as if no gesture has been made, and the player cannot progress. Progress is also hindered if players cannot adapt the gestures they have learned in response to changing affordances and constraints.

The ability to continue playing and complete the goals put forth by the game is thus dependent on players' capacity to imitate gestures, or find creative alternatives, and adjust the position and movement of their bodies to suit different contexts. Based on the observations gathered during this study, I argue that the gestures used to play *Kinectimals* are not necessarily transferrable to other contexts, and may represent a unique gestural repertoire that is developed differently by each individual player. I also suggest that those interested in using motion-based videogames for learning purposes consider imitation, exploration, and the adaptation of movements as forms of embodied competence that can easily be overlooked in the search for transferrable, "real world" skills.

## Methodology

The pilot study was carried out over the course of four weeks and involved 17 participants, aged 21-42. Participants were initially recruited through flyers and email lists. Participants were then asked to

invite friends or family that might be interested in taking part. Prior to beginning the study the researcher also played the game extensively.

The game, console, and video cameras were set up in a game research lab at Concordia University. Participants came in on an individual basis. After obtaining informed consent, participants were asked to play *Kinectimals* for up to one hour while being videotaped. The researcher remained in the room, but did not provide instructions on how to play, except when it was deemed absolutely necessary (i.e. when the participants appeared to be truly 'stuck' and could not progress in the game). Once the hour was up, or they had signaled that they were finished, participants were asked to fill out a brief questionnaire.

Several authors have argued for a situated approach to studies on learning and digital games (Arnseth, 2006; Squire, 2003). Hans Christian Arnseth states that "what is missing from research on computer gaming are more naturalistic studies of how players experience gameplay, how gaming is related to other activities in young people's lives and the diverse practices players engage in when gaming." The same might be said of motion-based videogames, which generate context-specific practices that involve players' bodies and their physical environments in relatively new and complex ways. While this exploratory study was conducted in a lab under contrived conditions, effort was made to allow participants as much freedom as possible in directing their own gameplay. The questionnaire was then used to gather information about what other activities participants were engaged in and how they recalled and articulated their gameplay experiences in writing. Though the small sample size and wide variation in experiential backgrounds made it difficult to draw any conclusions from the written data, the purpose of the questionnaire was partly to test the method and determine whether or not it might be effective in combination with videotaped observations.

### **From Embodied Cognition to Embodied Gameplay**

Recent theories of embodied cognition support the notion that previous experience with physical activities such as dance and sport might have an impact on how players perceive, interpret and respond to information while playing motion-based videogames. Embodied cognition has arisen partly in response to abstract models of cognition and artificial intelligence that downplay the role of specific input and output devices (Anderson, 2003). According to Margaret Wilson (2002), "Proponents of embodied cognition take as their theoretical starting point not a mind working on abstract problems, but a body that requires a mind to make it function" (625). From this point of view, the body's sensorimotor functions and the routine ways in which we interact with our environment have a profound impact on cognitive processing (Wilson, 2002).

Wilson (2002) notes that embodied cognition is a general approach that involves multiple distinct claims, several of which are encapsulated by J. J. Gibson's notion of affordances. Affordances are elements of the environment that invite particular actions and are directly related to the action potential of an organism's body (Wilson, 2002). In game studies, the term is often used to describe the potential actions made available to players by the material and formal properties of a game (Jenson & de Castell, 2009; Bayliss, 2007; Gee, 2007). Peter Bayliss (2007) combines Gibson's ecological approach with Dourish's work on embodied interaction and Norman's concept of natural mappings to develop a theoretical model of gameplay as an embodied phenomenon. Bayliss (2007) argues for an expanded model of gameplay that includes the physical space and body of the player, as well as the material, conceptual, and software components of the game and the interface. According to him, the relationship between these elements gives rise to affordances, and the players ability to perceive and react to these affordances may be considered as a set of embodied skills that allow the player to understand and internalize the logic of the game's rules. Bayliss (2007) also suggests that the more conceptually and functionally close the controls are to what they seek to emulate, the easier it will be for players to "form a functionally accurate understanding of those controls and deeper levels of the game" (101), presumably because the actions used to play the game are already familiar to players and have been used in a similar context outside the game. He goes on to add that, "there are always going to be some-degree of learning curves in videogames, but forms of enactive embodied gameplay, where appropriate, will...lessen the effect that this barrier might have to the player's enjoyment" (101).

Other authors such as Derek Burrill (2010) and Seth Giddings and Helen Kennedy (2010) also attribute significance to the changing relationship between players' bodies and videogame interfaces, noting that the macromovements involved in playing games such as *Kinectimals* mark a distinctive

shift from the tiny micromovements that characterize traditional videogames. For Jennifer Jenson and Suzanne de Castell (2009), this change is an epistemological one, redefining gameplay in such a way that imitation, as opposed to simulation, becomes the central element. While these two terms are often conflated, simulation creates an “as if” scenario and depends to a certain extent on the absence of the real. Imitation, on the other hand, depends on physically performing the activity being imitated, so that rather than pushing a button “as if” jumping, players must jump themselves in order to jump in the game (Jenson & de Castell, 2009).

The term imitation is often used in a commonsense way to describe the process by which an observer duplicates the actions of a model, however Richard Byrne (2005) argues that it is important to distinguish between *learning by copying* and *social mirroring*, each of which serve different purposes. Learning by copying allows for the acquisition of new skills and involves the decomposition of complex behaviour into simpler components that can already be performed by the observer, and the subsequent recomposition of those components into a new programme of behaviour. Social mirroring, on the other hand, may support mutual identification or empathy, and includes forms of imitation in which an observer matches the current behaviour of another through the performance of similar actions (for example smiling back at someone who is smiling). Though the underlying connections between observed behaviour and the actions performed by an observer are not well understood, studies have shown that imitation plays an important role in strengthening interpersonal relationships, facilitating communication, and enabling the learning of new skills and behaviour (Meltzoff & Williamson, 2008; Byrne, 2005).

### Bumble Says...

One way to examine imitation in motion-based console games is to focus on areas where it seems to fail. Observations revealed that swiping in order to scroll through menu options was perhaps the most challenging gesture to learn overall, especially in the initial stage when participants were required to select their cub before proceeding with the game. During this phase the virtual guide began by advising players that, “If ever you’re not sure what to do, just follow me and do what I do.” He then repeatedly demonstrated the swiping action in the corner of the screen and provided spoken instructions. While participants generally moved their hands around in response to the prompt, Kinect often failed to recognize their motions as “swiping,” either because they weren’t moving quickly enough, or because they weren’t moving their hands in the right direction (horizontally right to left with the right hand, and vice versa with the left).

Rather than swiping, many participants seemed to draw on their previous experience with virtual menu navigation, and tried to push the left and right arrow buttons bracketing their current selection by holding their hand out in front of them. While this was a logical solution, the arrow buttons in this case were non-interactive, and only served to indicate that there were other options available. Because the game required that players swipe with both the left and the right hand before they were allowed to move on, participants were stuck trying to execute what should have been a routine task.

There are a number of potential reasons why participants had difficulty with this gesture. Aside from language barriers and a lack of familiarity with videogame tutorial scenarios, one significant factor is that there is no obvious “real life” counterpart to swiping. While the motion is similar to flipping through the pages of a book, the gesture demonstrated by the guide in *Kinectimals* originates at the elbow rather than the wrist. Participants who did not immediately notice or understand the instructions appeared to learn the gesture either through trial and error, or by asking for help and watching the researcher, who would demonstrate the movement and say something along the lines of “like this.” While it is difficult to know exactly why the researcher was able to successfully teach the movement while the virtual guide was not, possible reasons include an increased level of attention directed at the researcher’s movements and the three-dimensionality of the demonstration. While the virtual guide can only be seen from a front-on perspective, participants were standing to the right of the researcher and could watch the gesture from above.

The situation described above suggests that learning by copying, even for a relatively simple gesture, is not guaranteed, and may be dependent on a number of factors including the familiarity of the gesture being demonstrated, a correlation between the context in which the gesture is being performed and the context in which the gesture has previously been used, the observer’s awareness that she is meant to be imitating the gesture and her willingness to do so, the amount of attention directed at the person or character demonstrating the action, and the ability of the observer to

translate what she or he sees into an embodied understanding of how and where to move. *Kinectimals* also lacks a sophisticated feedback system that could instruct players on what they were doing wrong and offer suggestions. Though participants were able to infer a great deal from what was going on in the game, they were sometimes unsure whether the error lay with them or with Kinect, and often turned to the researcher for help or reassurance. The inability of the game to communicate to the player precisely if, what, and how they were doing something “wrong,” and the resulting confusion, suggests that even relatively high-tech devices cannot replace a human coach or instructor, though future studies comparing the two methods of teaching might provide interesting results. On the other hand, the context set up by the game, which is often humorous and light-hearted, may afford more freedom for players to “goof around” and explore just what their bodies are capable of doing—a valuable learning activity in and of itself, particularly for young children.

## Variability of Gesture

The potential for error demonstrated in the above example is attributable in part to the many degrees of freedom afforded by the human body, which also allows for a wide variation in movement patterns. None of the participants had played *Kinectimals* before participating in the study, and each developed a slightly different technique for swiping, throwing, kicking, and otherwise interacting with the game. The variation in throwing strategies was particularly obvious. While most players began by using overhand (above the shoulder) throws, some seemed to be applying a great deal of force to their swing, while others used a technique that would be better described as flicking.

Strategies for throwing balls continued to change during the course of the play session, as some participants began to abandon traditional throwing techniques in favour of a slower, shorter swing, which seemed to be better suited to the game. The differences between the motion required to accurately throw a real ball and the motions used to play *Kinectimals* suggests that the game would not be useful in teaching advanced throwing techniques (“How to throw,” 2011). This is in part because Kinect cannot detect when the player is attempting to release the ball, and in part because the game guides the ball to a certain extent in order to make it easier to hit targets. The disjunction between the player’s physical space and the illusory space on the screen may have an impact on players’ perceptions of angles and distance as well. Also, because there is no physical object being thrown, the player lacks the haptic input that would allow them to determine the weight, size, and shape of the ball, and adjust their movements accordingly.

As Ian Renshaw et al. (2010) point out, however, movement variability is not in itself detrimental to motor learning. In fact, the opposite is true, as “variability in movement patterns permits flexible and adaptive motor system behaviour, encouraging free exploration necessary in dynamic learning and performance contexts” (125). Accurate throwing, for example, depends as much on the ability to alter the angle of the throw as it does on the ability to follow a predefined pattern or set of mechanics. Thus the ability of players to adjust previously learned movement strategies to fit the context afforded by the game and the interface could be approached as a skill in its own right—one that could potentially be improved through the use of motion-based videogames.

The two related claims in embodied cognition that “perception is for action” and “cognition is situated” suggest that context and purpose not only affect how people act, but also how they think (Wilson, 2002). If players are repeatedly encouraged to experiment with new movements and perform them in different situations for different purposes, it is possible that this may change the way they perceive their body and its capacities, as well as their environment. “Kicking the ball around” comes to take on new meanings when it becomes part of a repertoire of movements used to interact with a virtual environment, as well as something we do on the soccer field or in the arena.

While many videogames use avatars as a sort of stand-in for the player within the game space, the only representation of the player’s body in *Kinectimals* is a pair of semi-transparent, disembodied hands. The player’s ability to change their viewpoint or move around in the virtual space is also limited, which in turn limits the ways in which activities like jumping, ducking, and spinning can be incorporated into the game. This limitation is resolved in part by replacing a player avatar with the cub. In order to perform tricks in *Kinectimals*, players must first perform a specific gesture, which their pet will then “copy.” During the study, jumping was the first trick introduced, and while some participants were initially unsure what to do, they quickly realized that they themselves had to jump in order to make their cub jump. The “spin” trick, which required the player to spin in place, was then followed by the “play dead” trick. For this last trick, participants were instructed to lie on their backs, or

say, “Play dead.” If they were successful, participants were rewarded with an animation of the cub flopping over on his back.

This sort of one-to-one relationship between the players’ actions and the actions of the cub later proved to be misleading. When the “lie down” pose was introduced, most participants naturally assumed that they should also lie down, and were confused when the cub either performed the play dead trick or refused to do anything at all. In fact, the lie down pose was performed by leaning forward and patting both hands on the ground. Much like the swiping gesture, the lie down pose made a certain amount of sense in retrospect, since cats often lie down by tucking their legs beneath them. By establishing a link between everyday human actions and the cub’s actions, however, the game may have cued participants to draw on their own experiences of lying down, rather than copying and learning the action demonstrated by the guide.

Several participants also prompted their pet to perform tricks that were not demonstrated by the guide, either accidentally or through deliberate experimentation. The beg pose, for example, was often triggered by participants holding their hands close to their chest while watching the screen. Once they realized their movements could potentially trigger a trick, some participants began to try out new gestures. Aside from encouraging players to explore new movements, Byrne’s (2005) description of social mirroring suggests that the tricks activity might also have been designed to encourage players to develop an empathic relationship with their cub. The cub’s ability to mimic the player helps to establish a two-way relationship based on synchrony and mutual recognition. If the cub “sees” and responds to the player, the player may be more likely to see and respond to the cub, as well as other agents in the virtual world. When successful, imitation in *Kinectimals* can potentially create a feedback loop in which the player learns to copy the guide and the cub learns to copy the player, providing a fictional gloss that may help to naturalize the somewhat uncomfortable process of learning to jump and flail about in front of Kinect’s cameras.

## Discussion

Jenson and de Castell (2009) suggest that, “Imitative play...engages players directly with the forms and functions of the real” (6), however many of the activities in *Kinectimals* are a long way from being “just like” the “real” activities they pretend to emulate. The observations gathered during this study indicate that participants quickly learn to perform gestures that are effective for accomplishing certain goals in the game, but would be unlikely to have the same effect outside of the game’s virtual environment. Overall, the game neither encourages nor necessarily affords precise, directed movement patterns. Many of the gestures used to throw the virtual tennis ball, for example, lacked the physical force and follow through needed to accurately throw a tennis ball in real life. While *Kinectimals* may not be particularly helpful in teaching specific movement patterns that can be used in other contexts, the capacity to imitate an observed action and adjust one’s movements according to a set of affordances and constraints might themselves be considered as forms of “embodied competence” (Jenson & de Castell, 2009) that can be developed through imitative play.

The shifting gestural patterns that occur as players familiarize themselves with the interface and the game activities may also be indicative of an exploratory, communicative process in which players learn to detect what the game “wants” them to do, and modify their movement patterns and strategies in order to produce something it “understands.” In other words, the game relies on a loose gestural repertoire, which players must learn and enact in order to play the game. Often, players performed these gestures in order to manipulate objects in the game, blurring the distinction between gestures used to convey information and communicate with another agent, (Cook & Tenenhaus, 2009; Broaders et al., 2007; Goldin-Meadow & Singer, 2003), and non-communicative gestures used to manipulate or interact with objects (Montgomery et al., 2007). Though Kinect may provide the illusion of direct interaction thanks to the very short interval between the player’s action and the movement of the object in the virtual space, that interaction is dependent on communication as well as physical cause and effect.

Despite being designed for young children, playing *Kinectimals* involves a complex process of imitation, exploration, and adaptation as players contend with the limitations of the technology and the functional requirements of the game. Understanding this process will require a great deal more research, particularly given the enormous number of variables involved. While it might be easy to dismiss the situations above as examples of players not paying attention or not following instructions, it is far more interesting to ask what players were doing instead, and why.

## Future Research

The exploration of people's experiences and perceptions of new gaming technologies such as Kinect is one area in need of more in-depth research. Though the questionnaire used in this study was adequate for gathering basic demographic information, it tended to raise more questions than it answered about participants' perceived experiences and beliefs. A more effective approach might be to combine interviews with participant observation, and to extend studies over a greater period of time and to different locations. Additionally, researchers might look at how motion-based gaming is portrayed in the media, and what impact this has on players' expectations about what they can and should do when engaging in motion-based play. While such research might seem to be unrelated to learning, some have noted that in today's world, people can learn how to interact with new technologies long before they actually encounter them (Brooker, 2010). Although there may be plenty of anecdotal evidence to support this statement, specific studies investigating if, when, and how this occurs are still needed. Familiarity with high-tech devices, both those which exist already and those which are still in the realm of science fiction, may have a significant impact on the capacity of people to learn to play with Kinect and other motion-sensing systems.

Marking players' progression through a motion-based game, noting where they have difficulties, how they adapt to overcome them, what information they're given to help them do so, and how the margin of error impacts play, can not only provide valuable information for the development of future games, but may be used to develop teaching strategies which are better suited to promoting different sets of embodied skills (Hsu, 2011, Kissko, 2011). To advance the study of digital game-based learning (DGBL), close attention to the player needs to be combined with close attention to the game being played, and in the case of field research in particular, to the space in which it is played. Furthermore, DGBL research must be expanded beyond computer games to incorporate new interfaces and new modes of interaction.

If we accept that players are learning *something* from motion-based videogames, there is still the question of how applicable this learning is to other situations. Previous research has looked for improvements in areas such as surgical skill (Boyle et al., 2011; Hogle et al., 2008), golf putting technique (Downs & Oliver, 2009), and stepping ability in the elderly (de Bruin et al., 2010). While the results generally indicate that motion-based systems can be beneficial, they are not always a suitable replacement for real-life environments. The purpose of this paper is not to suggest that the transfer of learning from motion-based videogames to specific and externally defined tasks is impossible or unimportant, but rather that researchers and educators might benefit from a more holistic approach to embodied competence as something which involves the ability to dynamically alter gestures, as well as repeat them.

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## Gaming as a Gateway to ICT Careers: Case Studies of Two Female ICT Students

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**Abstract:** This study shifts inquiry from game-based content learning to broader transformational learning (Mezirow, 1997) stimulated through gaming practices transpiring longitudinally across social and formal/informal learning activities. Findings of this case study involving two young women highlight the *kinds of gaming practices* that participants actually pursue, the *social context* of gaming, and perhaps most importantly, the *meaning* of gaming for participants as crucial variables. Our study suggests that, beyond learning specific content, gaming became a significant “possibility space” for the participants. This was particularly true in relation to envisioning ICT careers, when other people (relatives, adult mentors) not only introduced them to new games, but to new practices around these games, and made explicit connections between these practices and future careers.

### Introduction

Given the ubiquity of the standardized content movement throughout K-12 education, there is strong interest in integrating game-based technology into the classroom as a means of delivering content (Federation of American Scientists, 2006). Research suggests gameplay stemming from commercially available video games may support standards-aligned learning in academic areas (e.g. Squire & Durga, 2008; Steinkuehler, 2007; Steinkuehler & King, 2009), as well as broader 21<sup>st</sup> century skills (King, 2012). However, the power of game-based learning extends beyond delivering content. As simulated worlds, games are constructed from particular viewpoints, offering players access to designed experiences (Squire, 2006). Interactive technology provides a low stakes sandbox to collect experiences (Gee, 2004) that push the boundaries of “known,” opening the world of possibility (King, 2011). Thus, “games are both tools for transformative learning [and] possibility spaces for meaningful experiences” (Mitgutsch, in-press).

While research points to specific forms of learning and cognition (e.g., Gee, 2003; Steinkuehler, 2008) that may transpire during gameplay, less is known about the deep, transformational learning (Mezirow, 1997) potentially sponsored through broader gaming activities situated across the lifespan (Bruner, 1986). This approach requires looking at gaming not as a “separate world” (Stevens et al., 2008) but as “tangled up with other cultural practices, which include relations with siblings and parents, patterns of learning at home and school, as well as imagined futures for oneself” (p. 64). Studies from this perspective have used ethnographic methods, particularly connective ethnography (Fields & Kafai, 2009; Leander & McKim, 2003), or more generalized cognitive ethnographic methods (Stevens, et al., 2008) to sharpen our understanding of the learning and meaning youth acquire through ecologies of gaming encompassing a variety of social interactions, informal and formal education. However, most of these studies have investigated a limited time span, typically a year or less. As Stevens et al. (2008) note, a limitation of this work is that “research also needs to look at gaming over time, taking seriously the idea that young people...have careers—with all that this term implies—as gamers, and that these careers lead young people toward particular experiences, people, and identities, and away from others” (p. 64).

### Study Objectives

Our study shifts inquiry from content learning to broader transformational learning (Mezirow, 1997) stimulated through gaming as it transpires longitudinally across social and formal/informal learning activities. While a study of this nature makes a contribution to the literature outright, this paper focuses on a longstanding issue in STEM fields—the under representation of women in ICT careers (Fisher, 2007). Although research has investigated this particularly vexing situation, women remain strongly underrepresented in ICT-related occupational areas. Recent research (Legewie & DiPrete, 2011) suggests that women’s STEM career decisions are strongly influenced by factors beyond skill mastery, most notably social factors (family, peers and role models) and the affective effects of high school coursework.

Previous research indicates interest-driven learning ecologies (Barron, 2006) offered through gameplay [particularly in conjunction with affinity space participation (see Gee, 2004)] are potentially efficacious for developing vocational aptitude and interest (Hayes & King, 2009; Hayes, King & Lammers, 2008; King, 2012-a; 2012-b), yet studies analyzing how these game-based experiences are situated across players' lifespan and lifespaces have been lacking. Gee & Hayes (2010-a) state, "Learning anything, at least anything deeply, always creates a history of reaching far back into the past and extending out into the future" (p. 91). This provides a strong rationale for the study's goal of considering how gaming, throughout the lifespan, as a fundamentally social practice, has the potential to not merely develop young woman's technical skills, but capture their imaginations, ignite their passions, and serve as gateways to new identities and life choices (Hayes, King & Johnson, 2012).

## **Study Methodology and Analysis**

Methodology for this case study (Stake, 1995) was informed by narrative (Reissman, 2001) and technobiographical (Henwood, Kennedy & Miller, 2001) methods that aim to collect the unique stories of participants, in particular, as associated with the use and implications of technology across their lifespan. Two female participants in their early 20s involved in longitudinal research for over five years with the study authors were purposefully selected (Creswell, 2006) based upon their participation in post-secondary education in ICT-related fields. Each participant represented a specific demographic: Nyght, a high-achieving student in her early 20s from an upper middle-class family, currently attends a private undergraduate college, majoring in computer science; Jade, a twenty year old student from a working-class, rural family, struggled in high school and is attending a private (for-profit) two year college specifically catering to ICT careers.

Both young women participated in an extensive narrative interview and follow up interviews that entailed mapping and reflecting upon significant life events related to digital media and gaming experiences. Interviews were based upon the Playful Learning Biography method (Mitgutsch, in-press) in which participants create a timeline of gaming and digital media experiences from childhood to present and then reflect on the significance of these experiences. In addition to mapping their game play, they were also instructed to design separate timelines and plot significant school and social events. Open-ended interview questions prompted participants to diagram life events along the three timelines and, thinking aloud (Ericsson, 1998), reflect upon the embedded learning and meaning, particularly addressing connections across timelines. The audio taped interviews were selectively transcribed for salient topics and coded for emergent themes and identification of significant learning moments. This then was correlated to each participant's hand-drawn timeline in order to obtain a more in-depth understanding of the sequential and developmental unfolding of events, particularly those contributing to developing skills, identity and support networks necessary to encourage pursuing a career in an ICT field. Essential themes and learning patterns were established for each participant and compared for similarities and differences.

## **Significant Themes Across Participant Life Trajectories**

Two significant themes emerged from the study: the introduction of digital media-creation practices as legitimate career activities by mentors, and the divergent, possibly social-class based, schooling trajectories taken by both women. Although both cite experiences with videogames as significant in their career choices, they have differing school and career trajectories.

Both participants were mentored by older, female role models who introduced them to gaming practices that extended beyond playing videogames and helped make the connection between creative practice as an amateur, and professional practice in related technical fields. While participants had multiple social connections who introduced them to a variety of games, being exposed to new practices, such as creating clothing for *The Sims* or add-ons for *World of Warcraft*, opened up significant "possibility spaces" in which they began to imagine future careers in ICT occupations. Mentors, whether in a single-gender after-school program or in the household, encouraged exploration in these "possibility spaces" by providing resources, pointing out alignment with IT careers, and serving as examples themselves.

An important characteristic of these mentoring relationships is that gaming, and in particular, self-directed learning and content creation in conjunction with game-based interests, constituted a social activity. However, "social" for these young women differed from the typical conceptualization of social when considering female predispositions to digital media and gaming activities that involve collaboration and communication (c.f., AAUW, 2000; Dickey, 2006; Taylor, 2003). Instead social

meant the ability to interact with significant people in their lives, to operate on their skill level. And, for both women, their activities in and around the game involved participating in the *collective* activities of peers and the community, rather than collaborating. Each derived deep satisfaction through developing their own area of skill and expertise and contributing it; *collaboratively* developing a mod, or a design was not a noted motivation. Instead, creating something (a piece of clothing, a piece of artwork, etc...) as a skilled artisan that was then offered as a part of the collective resources available to peers or the community was something they both indicated as a unique source of satisfaction and motivation.

The two participants, however, differed significantly in their school experiences and career trajectories. Video games inspired them to pursue computer-based technology careers, but the possibilities they discovered were quite different and clearly class-based, at least in part. Nyght benefited from consistent access to computers and multiple computer games from early childhood. Her parents encouraged computer game play, particularly educational games, from an early age. She even played videogames with parents and was introduced to the practice of add-on creation by her mother, who provided study materials and encouraged her own self-directed exploration. Nyght took an independent study computer science course in high school. While attending a four-year liberal arts college with the initial goal of being a biology major, she took an introductory computer science course in which she designed a game as her course project, which she found very satisfying: "Games in relation to computer science satisfied that creative part of my brain." She switched her major to computer science, and plans to attend graduate school where she hopes to use computers to "save the world."

Jade had uneven access to computers, software, game consoles, and the Internet. She creatively persisted in gaming by using shared equipment, often playing with extended family members and using lower quality tools for content creation. Her parents did not support computer gaming, calling it a "waste of time," and regimented technology classes in school alienated her. Not until she joined an after-school gaming club for girls did she find success with game-related computing, creating new game content and developing a new identity of herself as successful with art and technology. She credits this after-school learning experience for her desire "to be the first one [in her family] to go to college and graduate." Now, she knows "all the cool stuff you can do," in college and with computers.

Both participants played computer games throughout childhood and began to create digital media content for games while in middle school. Being introduced to these practices early in their lives influenced their choice of high school classes, although the two participants had markedly differing experiences. Nyght was given the flexibility of an independent-study computing course, while Jade experienced a boring, alienating, introductory-level graphics course. Despite their differing experiences, both moved into computer-focused courses of study in college—either enrolling in a technical college or choosing computer science as a major. Their differing college choices undoubtedly reflect in part their SES backgrounds—Nyght had college-educated parents who scaffolded her pursuit of higher education, while Jade was the first in her immediate family to attend college.

## **Discussion of Themes and Implications**

Some scholarship questions the role of gaming as a starting point for the study of computer science and related technical fields (e.g., Wilson, 2002). However, such research has simply used "playing games" or "time spent gaming" as the variables of interest, rather than investigating, as we have in this study, the *kinds of gaming practices* that participants actually pursue, the *social context* of gaming, and perhaps most importantly, the *meaning* of gaming for participants. Our study suggests that gaming became a significant "possibility space" for these young women, at least in relation to envisioning ICT careers, when other people—particularly relatives and adult mentors—not only introduced them to new games, but to new practices around these games, and made explicit connections between these practices and future careers.

Our study provides a strong case for the potential value of game-based educational programs that provide mentoring and build on young people's interest in games but introduce them to other, related ICT practices. The way in which students play games, and their relative expertise in that game may also be significant factors in opening up possibility spaces into which new ways of engaging with the game may enter. In both cases, the participant had hit a critical point in how she engaged with the game she was playing. Each participant had mastered the game as it was designed and was at a

cusp in which she was considering changing how she played the game or whether or not she would even continue with the game at all. Jade, for instance, had come into the afterschool group and expressed how she was getting bored with the *Sims*, sensing that she had exhausted its content and opportunities for novel experiences after years of gameplay. Nyght's experience, in contrast, was one of frustration with the limits of the interface of *World of Warcraft* since it did not provide information she needed to play the game well during challenging, group encounters. Both girls had attained a high level of mastery of their chosen game, which set the foundation for going beyond playing the game to mastering the system of the game via content creation and modification.

Our findings, however, suggest the need for broad conceptions of how gaming might be used to introduce young women (and men) to computing. Many educational programs attempt to use game design to teach a restricted set of programming skills, without considering participants' existing interests and goals. The young women in our study, in contrast, were initially engaged by creating game content, enhancing their existing game play. We posit that this approach was crucial to their ongoing interest in computing, as they learned to identify their own goals and direct their own learning.

The possibilities that these young women found in gaming were clearly mediated by their socioeconomic context and schooling. Gaming in turn affected their social and school experiences, leading them to develop different sets of aspirations and skills. The young women's families differed considerably in how they scaffolded game-related practices and learning. While we know from prior research (e.g., Heath, 1983; Lareau, 2003) that upper middle-class parenting styles more closely align with school norms and practices than those of lower SES families, researchers have given little attention to differences across social class in how video gaming is enacted, discussed, and valued within families. Furthermore, it was evident in our study that game-associated, out-of-school learning was recognized and valued quite differently in their respective high schools. Research documents how more advantaged students tend to experience additional opportunities for project-based ICT learning and the pursuit of higher level skills, while less advantaged students are relegated to rote learning and basic computer skills (Goode, 2010; Margolis et al., 2003; 2008). Jade persisted—but only barely—and we wonder how many others would have given up.

While we may celebrate the knowledge and abilities that young people develop through gaming, if this learning is not similarly recognized and valued in schools or formal credentialing systems, it may simply contribute to further alienation and disaffection from formal education and its associated opportunities. Interestingly, similar implications have been discussed in research concerning the game-based literacy practices of boys who are disaffiliated in school and the disconnect between recognizing academic looking practices or activities that may constitute academic-like learning practices (c.f. Gee & Hayes, 2010-b; King, 2012-b; Steinkuehler, Compton-Lilly & King, 2010; Steinkuehler & King, 2009) or preparation for future learning (Bransford & Schwartz, 1999) in career contexts (c.f. Hayes, King, Herro & Johnson, 2012; King, 2012). Often this discussion sparks the consideration of potential systems for formally credentialing out of school learning. The cases involved in this study can contribute to the ongoing discussion of badge and credentialing systems in informal digital media spaces (c.f. DML: Badges for Lifelong Learning) by encouraging learning environment designers to consider the importance of mentors and mentoring in helping participants develop necessary identities (Gee & Hayes, 2010-b) and clarifying the relevance of competencies and dispositions that go beyond the mere performance of skills (King, 2011; 2012-a).

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# The Impact of Choice and Feedback on Learning, Motivation, and Performance in an Educational Video Game

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**Abstract:** This study modified an existing educational video game by varying a learning mechanic and an assessment mechanic. The result was multiple versions of the same game with identical game mechanics but different learning and assessment variables. The impact of these variables was examined to determine their impact on three dependent variables: learning, motivation, and in-game performance. One hundred thirty-eight ( $N=138$ ) sixth grade students were randomly assigned to play one of the four versions of the game. After thirty minutes of play, results suggest that providing players with a choice of non-player character from whom to receive feedback results in significantly higher learning outcomes and desire to continue playing compared to a non-choice condition. Comparisons between informative and elaborative feedback did not influence student any of the dependent variables. The theoretical and practical implications of these findings are discussed within the context of educational game design and research.

## Introduction

Educational video games by definition, regardless of genre or quality, must contain a number of learning-related variables. Unfortunately, many games intended to educate, currently lack coherent connections to theories of learning or underlying bodies of research (Shaffer, Squire, Halverson, & Gee, 2005). This gap between theory and practice has resulted in video games that may be enjoyable, but do not support academic learning (Barab, Thomas, Dodge, Carteaux, & Tuzun, 2005). To help reverse this phenomenon, the Games for Learning Institute (G4LI) has urged educational game designers to distinguish between and consider in their designs three categories of mechanics: game, learning, and assessment (Plass et al., *in press*; Plass, Homer, Kinzer, Frye, & Perlin, 2011a).

## Literature Review

### Game, Learning, & Assessment Mechanics

When carefully designed and implemented, game, learning, and assessment mechanics can work in concert to create a game experience that is effective both as a play experience and as a learning/instructional experience.

Perhaps the most familiar concept to game designers is that of the game mechanic, since much has been written on the topic (see Bjork & Holopainen, 2005; Fullerton, Swain, & Hoffman, 2008; Salen & Zimmerman, 2004). For the purposes of this study, game mechanics describe the essential game play activity and are distinct from learning mechanics and assessment mechanics. Well known game mechanics include leveling, resource management, and turn taking. In contrast, learning mechanics according to Plass et al. (*in press*) are grounded in learning theory and describe specialized activities that have learning as their primary objective. Learning mechanics are theoretical in nature and must be instantiated in the game space through the use of game mechanics. For example, the well-documented instructional practice of peer-tutoring (see Topping, 1988), might be incorporated into a game by requiring players to generate authentic problems to be solved by other players. Similarly, assessment mechanics are grounded in test theory and are specialized activities that have assessment as their primary objective (Plass et al., *in press*). An example, drawing on adaptive testing theory, is a game that progressively challenges players by adaptively adjusting and setting the difficulty level based on player performance.

### Choice as a Learning Mechanic

The learning mechanic targeted in this study was choice. Research has shown that providing students with choices can increase self-efficacy, motivation and learning. The motivational aspects of choice have been part of many motivational frameworks, such as Eccles & Wigfield's (1995) expectancy-value theory, Bandura's (1997) social cognitive theory, and cognitive dissonance theory (Collins &

Hoyt, 1972). For example, the concept of self-efficacy is the belief in one's capabilities "to organize and execute the courses of action required to produce given attainments" (Bandura, 1997, p. 3). Recently, Leotti, Iyengar, & Ochsner (2010) 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).

Several researchers have examined the relationship between choice and learning. Zuckerman, Porac, Lathin, Smith, & Deci (1978) assigned 40 students each to a choice or no-choice puzzle-solving condition. Individuals in the choice condition reported a greater feeling of control, greater willingness to participate in another solving session, and spent significantly more time on similar puzzles in a free-choice period at the end of the experiment. Cordova & Lepper (1996) investigated the effects of choice on elementary children's learning within a computer game. Subjects made choices on features that are not relevant to the pedagogical aspect of the game. The results showed that even minimal choices produced a significant increase, not only in the participants' motivation, but also in the depth of their engagement in learning, as evidenced by a preference for more challenging versions of the game, the greater use of complex operations, and an emphasis on strategic play. Moreover, the amount they learned increased, as did their perceived competence and level of aspiration.

This brief overview demonstrates that choice in a game environment might be leveraged to influence learning, motivation, and in-game performance. For this study, the variable of choice was operationalized by providing players with a choice as to the non-player character (NPC) that would act as their "guide" during the game. These NPC guides provided feedback to players in the case of incorrect answers. Players in the Choice condition (C) could manually select a guide from six potential NPCs. Players in the Non-choice condition (N) were assigned guides automatically in the same proportions as those players who selected their own.

### **Feedback as an Assessment Mechanic**

The assessment mechanic varied in this study was type of feedback. Feedback is arguably one of the most studied areas of learning and instruction and has a rich history in instructional theory. Research on feedback generally confirms that learners are more effective when they attend to externally provided feedback (Butler & Winne, 1995, p. 246). Furthermore, feedback has "the capacity to turn each item of assessed work into an instrument for the further development of each student's learning (Hyland, 2000, p. 234). In addition, external feedback has been shown to influence how students feel about themselves both positively and negatively, and what and how they learn (Dweck, 1999).

Video games, both educational and recreational, are filled with feedback. Many games use visual and audio feedback to let players know if certain actions have succeeded or failed. Such feedback communicates, to the player, details about the game's inner sates and its core mechanics (Adams, 2009, p. 225). In video games, feedback is half of the "circular model of gameplay," where the "gamer's input and the game's output reciprocally influence each other" (Heaton, 2006).

To operationalize feedback in the studied game, the researchers provided players with one of two types of feedback: informative or elaborative. The informative feedback was similar to what Kluger and DeNisi (1996) called "knowledge of results", which from an assessment perspective, is of little value as it does not elaborate on why the answer was wrong, just that it was wrong and not the desired outcome. The second type of feedback was termed elaborative. The goal of the elaborative feedback was to provide players with more applicable information on what to do to correct an error when an incorrect answer was submitted.

### **The Current Study**

This study aimed to examine the impact of these learning and assessment mechanics on three dependent variables: learning, motivation, and in-game performance. The overarching question was if and how the inclusion of each of these theoretically based, non-game mechanics would alter these important aspects of games for learning.

The first research question focused on the role of player choice in selecting a NPC to serve as an instructional guide throughout the game. Will giving players control over which character provides feedback influence learning, engagement, and in-game performance? It was hypothesized that providing players with choice would positively impact all three variables.

The second research question centered on which type of feedback, elaborative or informative, would have a more positive impact. It was hypothesized that elaborative feedback, which is meant to guide the player toward the correct solution, would result in higher player motivation, ultimately leading to better understanding of the instructional material and more efficient in-game performance. Conversely, informative feedback, which simply confirmed that an answer was incorrect, was hypothesized to offer little additional value to players, resulting in lower motivation and a reduced understanding of the instructional material.

A third research question focused on the potential interaction between choice of NPC and feedback type. If a player is allowed to choose a NPC, but that NPC only gives informative feedback, will the affordance of choice alone be enough to off-set receiving the presumably less valuable informative feedback? If so, to what degree will the results be measurable?

## Methodology

### Design and Participants

To explore these questions, a two-factor study with an experimental design was conducted. One hundred and thirty-eight ( $N=138$ ) sixth graders were randomly assigned to one of four conditions. These four conditions were based on two experimental factors: choice of NPC (C) versus no-choice of NPC (N) and style of feedback, informative (I) versus elaborative (E). This resulted in four randomized experimental groups summarized in Table 1.

	Choice (C)	No-Choice (N)
Elaborative Feedback (E)	$N = 35$	$N = 37$
Informative Feedback (I)	$N = 34$	$N = 32$

**Table 1: The four experimental groups and the number of participants per condition.**

### Procedure

The experiment lasted two days, consisting of approximately two instructional periods. The Day 1 session consisted of introducing participants to the project, answering questions, and conducting a 15-minute paper-based pre-test with 21 questions about the game's educational content (see standards 4.G, 4.MD, 4.OA, 5.G, 7.G, and 8.G in National Governors Association Center for Best Practices, 2010). On Day 2, participants were given one 30-minute play session followed by a paper-based post-test. Students were told that the game consisted of six chapters and the goal was to advance as far as possible in thirty minutes. Students played individually at computer consoles, with a pair of headphones and "scratch" paper for note taking. After thirty minutes, students were asked to exit the game and the paper-based post-test was administered. Students were given approximately 15 minutes to finish the test, which marked the end of the study.

### Instruments and Measures

#### Educational Video Game

The educational video game used for this study was *Noobs vs. Leets: the Battle of Angles and Lines*. This game was developed by researchers at the G4LI and was previously shown to be an effective educational intervention (see Plass et al., 2011b). The game teaches angle rules and has a simple story in which players help save their friends by unlocking paths represented by lines and angles. The paths are unlocked by solving for unknown angles. Each of the game's six chapters introduces a new concept about identifying and calculating angles. For example, the first chapter starts with types of angles (e.g., acute, obtuse, right, etc.) and their numerical values. As players progress through the game, they are required to apply more complex concepts, such as the complementary, and supplementary angles rule. At the beginning of each chapter, players are provided a brief video tutorial about the new concepts covered. In total there are six chapters and the game increases in difficulty with each chapter.

For the experiment, modifications to the original game produced by the G4LI were made. The first change appeared before participants started playing the game. Depending on experimental group, players were asked to select a NPC (Choice condition) or auto-assigned a NPC (No-Choice condition). In both conditions, players were told the NPC guide would "give you hints and tell you how you're doing." Students in the choice condition were given an array of six characters to pick a guide

from. These character images were selected from previous G4LI research (Turkay, Hoffman, Gunbas, & Chantes, 2011) and included three of the most liked and three of the least liked avatars. In the No-Choice condition, the game automatically assigned players one of the characters from the six made available in the choice condition.

The other variable manipulated in the game was the type of feedback presented to the player when an incorrect answer was submitted. This feedback was displayed in a panel that would drop down from the top of the screen. In this panel, the player would see their "guide", the character that they had selected or were assigned, and a speech balloon with text. This text was also spoken by a voice-over recording that matched the gender of the NPC. In the Informative condition (I), the feedback told the players what they did wrong. For example, if the player clicked on an angle that was too big, the NPC would say, "The angle you selected is bigger than 90 degrees." In the Elaborative condition (E) the feedback provided information about what the players needed to do to find the correct answer. For example, if a player clicked on an angle that was too big, the non-player character would say, "For 90 degrees, look for two rays which are perpendicular to each other." Each piece of feedback was preceded by a randomly selected preamble, such as "I'm sorry that is incorrect" or "This is not quite right." The preambles were the same for both conditions. The panel in which the NPC appeared could be dismissed at any time by clicking a close button. This feature allowed players to interrupt and remove the feedback at any time. Players also had the option of repeating the audio feedback by pressing a button labeled "Repeat."

### Learning Measures

This study used several methods of data collection in assessing the potential gains in learning and engagement motivation. To test both prior knowledge and post-intervention knowledge, a paper-based test was designed by the researchers, which covered the topics introduced in the game. The pre- and post-tests both assessed the participants' knowledge of angle types (9 questions), angles within triangles (4 questions), angles within quadrilaterals (2 questions), and the rules concerning complementary, supplementary and corresponding angles (6 questions).

### Motivation Measures

Motivation was measured using in-game questions presented at the end of each chapter. After each of the six chapters, students were asked to answer five questions about their experience. Using a five point Likert scale (1 = "Not at All"; 5 = "Very Much") students were asked about their engagement in the game. The five questions included: 1) How much fun was this part of the game?, 2) How difficult was this part of the game?, 3) How much do you want to continue playing this game?, 4) How interesting was this part of the game?, and 5) How helpful have your character's hints been in this part of the game? Answers to these questions were required in order to proceed to the next chapter. All answers were recorded in log files.

### Performance Measures

In-game performance was recorded using detailed log files kept during game play. These log files recorded all actions taken within the game environment. This included speed of game play, correct and incorrect answers, answer attempts, length of time on feedback screens, and more. These files were subsequently parsed and analyzed to extract data about each participant's specific in-game actions.

## **Results**

A preliminary analysis was conducted to ensure the four experimental groups were equivalent in prior knowledge at the beginning of the experiment. This was done by comparing the pre-test scores of the four groups. A one-way between-subjects ANOVA found no significant difference between the four groups.

The researchers' first question asked whether providing players with a choice of NPC would influence learning, motivation, and in-game performance. Since the two groups, choice (C) and no-choice (I), did not differ significantly on their pre-test score, an independent samples *t*-test was conducted. The test found no significant difference in the post-test score of the two groups. The next logical step was to look at whether there was a significant change from the pre-test to the post-test for the two groups. A paired-samples *t*-test found a significant change from pre-test score to post-test score for subjects in the Choice condition ( $t = 4.043, p < .001$ ). The mean pre-test score for subjects in the choice

condition ( $M = 11.406$ ,  $SD = 4.860$ ) increased at the post-test ( $M = 12.906$ ,  $SD = 5.283$ ). A paired samples  $t$ -test found no significant change from pre-test to post-test for the No-choice group.

Next, the researchers turned to whether or not having a choice of NPC would influence subjects' self-reports of engagement. Each question was answered on a five-point Likert-scale (1 = "Not at All"; 5 = "Very Much"). The analysis examined responses provided at the end of chapters one through three. Responses to chapters four through six were not analyzed because not enough players completed those chapters in the allotted time.

The first question asked players to report the amount of fun they had in the chapter they just completed. Independent samples  $t$ -tests found no significant differences between the C and N groups at the end of all three chapters. It should be noted, however, that the C group reported higher mean fun ratings than the N group. These differences were not statistically significant. The second question inquired about how difficult the chapter was. Independent samples  $t$ -tests found no significant differences between the C and N groups at the end of each of the three levels. The third question was about the subjects' desire to continue the game after completing a chapter. No significant difference was found between the C and N groups at the end of chapter one. A significant difference was found between the two groups at the end of the second chapter ( $t = -2.00$ ,  $p = .047$ ). The C group reported having a higher desire to continue ( $M = 4.32$ ,  $SD = 1.098$ ) compared to the N group ( $M = 3.88$ ,  $SD = 1.409$ ). However, no difference was found at the end of chapter three, although the average desire of the two groups was quite high at the end of this chapter, with the C group reporting the highest desire to continue ( $M = 4.51$ ,  $SD = .952$ ) compared to the N group ( $M = 4.06$ ,  $SD = 1.045$ ). A fourth question asked about subjects' interest in the game. An independent samples  $t$ -test found no significant differences between the C and N groups at the end of each of the three chapters. The fifth and final motivation question asked about the perceived helpfulness of the NPC guide. An independent samples  $t$ -test found no significant difference between the two groups at the end of the three chapters as measured by self-report. However, it should be noted that the C group reported higher helpfulness scores on average when compared chapter by chapter with the scores reported by the N group; however, the differences were not statistically significant.

The third aim of this study was whether or not the choice mechanic would influence in-game performance. Three measures of in-game performance were used: 1) the total number of completed levels, 2) the total time (in seconds) per level, and 3) the number of incorrect answers submitted for chapters one, two, and three. An independent sample  $t$ -tests found no significant difference in the total number of levels solved by each group or the average number of seconds spent per level. In terms of the number of incorrect answers submitted, no significant difference was found between the two groups after the first chapter. However, a significant difference was found in the second chapter ( $t = -0.130$ ,  $p = .044$ ) with the C group averaging more incorrect answers ( $M = 24.45$ ,  $SD = 15.633$ ) than the N group ( $M = 24.06$ ,  $SD = 24.06$ ). No significant difference was found for the third chapter.

The same three research questions were also asked of the assessment mechanic embedded in the game: informative versus elaborative feedback. To examine how feedback type influenced learning the researchers first examined whether the two groups differed significantly in their pre-test score. An independent samples  $t$ -test found no significant difference between the two groups. They also did not differ significantly on their post-test scores. There was, however, a significant change between the pre-test and post-test score of the E group ( $t = 3.128$ ,  $p = .003$ ). A significant change pre-to-post was also found for the I group ( $t = 2.086$ ,  $p = .041$ ). The change between the pre- and post-test between the two groups was not statistically significant.

The second research question asked if feedback type would influence subjects' engagement self-reports. No significant differences were found for any of the measures between the two groups on the examined chapters one through three.

Finally, three measures of in-game performance were compared across the two feedback groups. No significant differences were found for the number of levels completed and the average time spent per level. In addition, no significant differences were found between the two feedback groups as measured by the number of incorrect answer submitted in chapters one, two, and three.

Thus far, the analysis examined two variables, choice type and feedback type, independently. These independent analyses show some significance in terms of pre-to-post gains between the C and N

conditions. However, no significant difference was found between the informative and elaborative feedback types. This result suggests that having a choice of NPC character impacts student learning while feedback type does not. With this in mind, the researchers examined the impact of both variables using a two-way factorial analysis. The results of this analysis show that when examined together neither choice nor feedback were significant predictors of students' learning.

## Discussion

The first goal of this study was to provide a concrete example of how educational games can be thought of in terms of distinct mechanics that work together to create a fun yet educationally valuable experience. By thinking of games and their effectiveness in terms of game, learning, and assessment mechanics, educational game designers have more powerful lenses through which to reflect on why games work or do not. The researchers and the G4LI feel this is a valuable contribution to the field.

The second goal was to examine the effectiveness of two specific candidate mechanics: the learning mechanic of choice and the assessment mechanic of feedback. The results show that providing players with a choice of NPC positively influences learning outcomes, as well as aspects of motivation and in-game performance.

Perhaps the most intriguing finding of the study is that although students in the choice condition answered statistically more problems incorrectly than the no-choice group, their average reported interest and desire to continue were higher than the no-choice group. In other words, despite submitting more incorrect answers, the choice group reported having higher levels of motivation for the game. This is rather counter-intuitive in that one might expect submitting more incorrect answers to elicit greater negative affectation. In this case, however, it seems that the choice of NPC offset or protected against the negative experience of answering incorrectly. This is rich area for further study.

Another important area of discussion is the study's instantiation of the choice mechanic. Recall that learning mechanics are by definition theoretical and must implemented concretely within a game's ecosystem. The current study chose to do this through the use of a NPC character selection screen presented before game play began. This is, of course, but one way to instantiate choice; there are many other possibilities worthy of exploration. How else can the choice mechanic be operationalized within a game context? Are some instantiations more effective than others? For example, what if players could choose a new NPC guide at the end of each chapter of the game? How would this impact learning, motivation, and in-game performance?

Finally, the researchers hypothesized that different types of feedback would influence students' learning, motivation, and in-game performance; this turned out not to be the case. This does not mean that feedback cannot or should not be used as an assessment mechanic in educational games. Indeed, feedback has a long and well-argued history in education. The lack of a significant effect in this study is likely to have more to do with how the mechanic was operationalized rather than some inherent issue with feedback itself. For example, perhaps the two types of feedback were not different enough to elicit any change. Another possibility is that the elaborative feedback simply wasn't elaborate enough to help the target audience. Clearly, other explanations exist and more research is needed to find the best ways to implement feedback into games for learning. The point is that distinguishing between game, learning, and assessment mechanics is a useful approach to organizing and implementing iterative games for leaning research.

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# **Greenify: Real-World Missions for Climate Change Education**

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**Abstract:** The literature on climate change education recommends social, accessible *action-oriented* learning (Cordero, 2008; Bell, 2005) that is specifically designed to resonate with a target audience's values and worldview (Leiserowitz, 2006; Nisbet, 2009). This paper discusses *Greenify*, a Real-World Action Game (RWAG) designed to teach adult learners about climate change and motivate informed action. Evidence suggests that gameplay helped players realize the magnitude of their personal actions, with reports of new behaviors and an increased desire to educate others on the website and beyond.

## **Why a Social Media/Gamification-Based Strategy to Address Climate Change?**

Despite effort spanning several decades to mobilize the public around the issue of climate change (e.g., Nisbet, 2009), few people take actions to mitigate personal emissions (Owens, 2000) and climate change remains low in voters listing of national priorities (Leiserowitz, 2006). This reluctance to take action is often explained by an *information deficit* model (Burgess et al., 1998), which cites gaps in knowledge including incomplete or erroneous understandings of the causes of global warming (Bord, O'Connor, & Fisher, 2000; Seacrest, Kuzelka, & Leonard, 2007; Fortner, 2001; Sundblad, 2008; Bostrom et al., 1994). However, achieving a better public understanding of climate change does not necessarily lead to the desired behavior change (Leiserowitz, 2006; McKenzie-Mohr, 2008; Owens, 2000; Finger, 1994). Some studies have even found, perhaps counter-intuitively, that *better-informed Americans are less likely to take personal action rather than more* (Kellstedt, Zahran, & Vedlitz, 2008; Moser, 2006).

Broadly, recommendations for future education efforts promote action-based learning and consideration of the individual within their socio-cultural contexts. First, major barriers to climate change education efforts include polarization of the issue across ideological lines (Nisbet, 2009) and distrust of institutional sources of information (Nisbet, 2009; Owens, 2000). As such, climate change messages should be tailored to resonate with the worldviews and values of each target audience, ideally developed and delivered by among peers (Leiserowitz, 2006; Nisbet, 2009; Owens, 2000). Second, effective behavior modification leverages normative and committing power of social groups rather than focusing on the individual (McKenzie-Mohr, 2008). Third, knowledge acquired in an action-based and meaningful context promotes behavioral change (Epstein, 1994; Cordero, 2008; McKenzie-Mohr, 2008) by building self-efficacy (Nisbet, 2009; Owens, 2000) and forming the individual and social basis of new behaviors (McKenzie-Mohr, 2008).

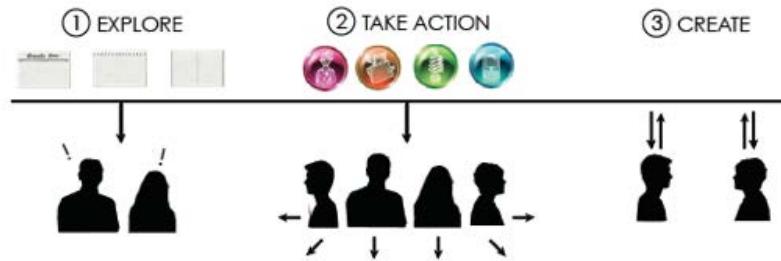
Social web-based applications hold promise for implementing these recommendations for climate change education. These sites enable the formation of online communities built upon common interests and values, which generate and share enormous varieties of relevant content. For instance, *Wikipedia* users have created one of the most extensive encyclopedias in the world with over 18 million articles in 279 languages and 400 million monthly users (Cohen, 2011). Importantly, the online interaction afforded by a crowdsourced environment like *Wikipedia* creates a community with a common purpose and relatedness, resulting in motivated contributors and senses of reciprocity and altruism (Kuznetsov, 2006).

Along with social web features, *gamification*, defined as the use of game design elements and principles to engage users in real-world activities, may be an important technique for motivating and scaffolding actions in everyday life (Schell, 2010; McGonigal, 2011). As an example, *Nike Plus* allows runners to set goals, join challenges, connect with friends in the online community, and, since its launch in 2006, has motivated users to run over 262 million miles (Malinowski, 2010). Principles of good game design are consistent with contemporary learning theories and can be used to build experiences that guide players to mastery of complex and difficult material (Gee, 2005). Echoing the promotion of action-based learning from the fields of climate change education (e.g., Cordero, 2008) and instructional design (e.g., Merrill, 2007), Gee (2011) argues that good games recruit good learning because they facilitate learning through completion of actions and authentic tasks. Additionally, the game *FoldIt* provides a powerful example of gamification-based crowdsourcing: its tens of thousands of players recently deciphered the physical structure of a protein implicated in AIDS, an optimization problem which had previously eluded the world's top supercomputers. This kind of strategy can be a useful way to get many people actively and creatively engaged in difficult problems.

## Greenify: User-Created, Crowdsourced Real-World Missions

Incorporating elements of both social media and gamification, an online, social Real-World Action Game (RWAG) called *Greenify* was created to teach about the causes and effects of climate change in terms relevant to players' everyday decisions and actions. *Greenify* provides (1) a mode of peer teaching and learning, moderated by climate science experts; (2) motivation to take action in the form of real-world missions, social recognition, game structures, and both in-game and real-world rewards; and (3) knowledge about climate change in the form of user-generated articles, news, scientific concepts, and multimedia.

The *Greenify* website is divided into three main sections: *Explore*, *Take Action*, and *Create* (see Figure 1 below for an overview). In addition, the website features a *Recent Activity* feed and a *Wall of Fame*. Details of each section are provided below.



**Figure 1: Explore Articles, Take Action (Missions) and Create New Content.**

Players can read three kinds of articles within the *Explore* section (Figure 2 below): *News*, *Scientific Concepts*, and *Stories*. *News* articles include a brief summary and links to recent news articles on climate change. *Scientific Concepts* teach players about fundamental climate change concepts such as albedo and the greenhouse effect. Finally, *Stories* include personal accounts of how climate change has impacted one's local environment. The *Explore* section, filled with insightful articles, embedded videos and interactive simulations, serves as a crowdsourced, collective knowledge sharing environment since it makes sharing articles from other resources possible on the *Greenify* website. Players can view highly rated *Explore* articles and boost article ratings by pressing a “+1 Alert” button, thereby boosting the article’s *Alert* score. Reading *Explore* articles increases the “intelligence” score of a player’s polar bear avatar.



**Figure 2: Main page, with Explore Articles and Take Action (Missions) sections.**

In the *Take Action* section, players can browse and accept real-world missions in three categories: *Personal*, *Resources*, *Energy*, and *Communication*. Missions are user-generated and vary from practical everyday actions that reduce carbon emissions to missions that involve problem solving or sharing creative ideas to complete. All missions feature step-by-step instructions and a *Why it Helps* section that explains the mission impact. Players earn a number of *Tree* points for completing missions. Missions are rated by all players for their potential impact and the average rating score is displayed; highly rated missions yield a

greater number of *Tree* points when completed. Deeds (players' completed missions) are also viewable and can earn "Thumbs-up" votes.

The *Create* section encourages players to create new missions (practical actions) and *Explore* articles for others. Submitted missions and *Explore* articles are vetted and approved by a team of climate science experts before they are live and playable on the site. Importantly, *Greenify* is designed to inspire players to want to inspire change among their social circle; players earn a number of *Tree* points for creating missions, and earn more points when their missions are rated highly and each time missions are completed by other players. In this way, the game naturally encourages people to take ownership over climate change issues and gets players to want to create high quality, scientifically sound, practical actions for their peers.

The *Recent Activity* section is a news feed that displays recently completed missions and updates. Players can comment on each others' activities, initiate and accept friend requests, etc. The *Wall of Fame* displays badges and superlatives in the form of top scorers and most popular missions. Finally, leaderboards and player scores display the players with daily, weekly, and all-time high scores for *Tree* points. Customizable polar bear avatars, with their happiness scores and intelligence level, are also viewable. Recently completed missions increase the happiness score of the player's pet polar bear.

## Methodology

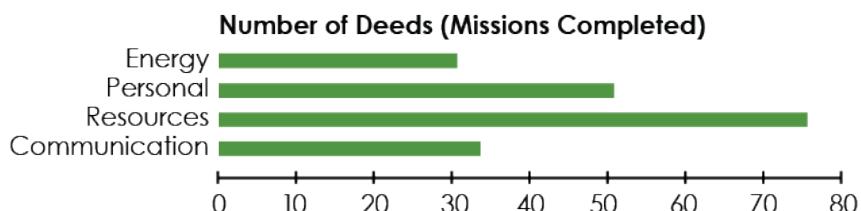
As the first iteration of a *Design Based Research* (DBR) mixed-methods approach (DBRC, 2003), 26 adults from two graduate-level courses at a large private university in New York were selected as part of a convenience sample. 8 men and 18 women participated in the six-week study. Participants were given a pre- and post-implementation survey, each with three types of question items about climate change: 12 questions testing basic knowledge about climate change, 15 Likert-type items exploring attitudes, 7 Likert-type questions looking at participant behaviors, 3 open-response essay questions, and 10 questions about the *Greenify* design and what players perceived as its impacts on their behaviors, attitudes and knowledge. Semi-structured interviews were also administered to six students, focusing on the positive and negative aspects of the experience, the effects of the game on their behavior, what they learned, etc.

## Results

Our findings suggest that players: (1) changed behaviors and learned practical actions to influence climate change; (2) reported an increased awareness of climate change issues and indicated an increased sense of self-efficacy to be able to make a difference; and (3) were encouraged to share knowledge, deeds and ideas with their peers in a form of "positive peer pressure."

### Theme #1: New Behaviors Occurred Because of Gameplay

In-game behavior logs revealed that during six weeks of gameplay, 27 missions were completed a total of 193 times (see Figure 3 for a breakdown of deeds by category). Nine *Resources* missions, including missions that challenged players to reuse bags for shopping purposes and to create homemade eco-friendly cleaning products, were completed (a total of 76 times). Six *Personal* missions, including missions to donate unwanted items or to eat organic and vegetarian meals, were completed 51 times. Three *Energy* missions, including shutting down the computer when not using it, and choosing to take public transportation to work instead of driving, were completed 32 times. Nine *Communication* missions, characterized by peer communication-based tasks such as debating climate change issues and sharing news, information and photos, were done 34 times. Examples of *Communication* missions include "*Debate: Where Can We Trim?*", which asked players to discuss which economic sector and what specific actions could lead America to decrease its carbon footprint the most, and "*Picture the Problem*", which allows players to earn points for uploading photos that highlight the problem of climate change.



**Figure 3: Breakdown of Missions Completed.**

In addition to game logs, survey outcomes demonstrate evidence of *Greenify*'s influence on players' everyday activities and behaviors. Nearly all participants (82.6%) reported that *Greenify* changed their behaviors, with 13.8% reporting a score of *Strongly Agree* on 7-point Likert scale items. When asked what

new behaviors resulted by playing the game, participants gave a wide variety of responses, including: "Started talking about the issue more with friends and family. Did more reading about the topics found on *Greenify* and took a few challenges and incorporated them into my daily routines."; "Reduced the amount of beef I eat and made changes around the house to conserve energy."; "More recycling and thinking more about my actions prior to purchasing items that might impact the earth."; "Didn't take plastic bags."; "Used public transportation instead of a car...use more organic products."; "Donated clothing and other used goods.", "Complete missions created by others, not just for one time, I tried to continuously follow the missions in everyday life...changed my everyday behavior by saving water, electricity, and disposable goods"; "Use less water and electricity- I put post-it notes around my house reminding everyone to turn the lights off."

Notably, Likert scale item responses determined that participants at least *somewhat agreed* in the post-survey that they became more careful about the kinds of foods (61.6%) and personal products (65.4%) they buy because of the issue of climate change (an increase compared to 46.1% and 46.2%, respectively, in the pre-survey). Further, the number of players who reported taking practical steps to curb transportation-based emissions rose from 30.8% before playing *Greenify* to 50.0% after. In the end, nearly all participants (92.3%) reported that they changed their behavior as a result of their understanding of climate change (compared to 65.4% on the pre-survey), and half made solid efforts to make changes around the household because of climate change, compared to just over one-third (34.6%) in the pre-survey.

Qualitative data from interviews also supported this finding, as participants reported paying more attention about climate change issues. For example, Laura (female) remarked:

"Actually, I didn't pay any attention about the global warming and all the environmental issues before. But now by playing *Greenify* I actually I pay more attention about little things and knowledge, like I actually didn't know the ordinary activities I do can change things."

*Greenify* players became more aware of how their actions impact the environment. For example, Laura (female) in an interview explained how *Greenify* changed her awareness of personal habits and how she felt more empowered to do simple actions to make a difference:

"I'm a little bit ashamed but actually I would let the water run whenever I'm brushing my teeth everyday and I didn't feel bad about it. But now immediately after first time I saw the activity I stopped that. I definitely turn off [the water] when I'm brushing my teeth and...I feel good about it, I feel you know I'm really making an impact."

Similarly, Mary (female) talked about household behavior changes because of *Greenify* missions:

"I actually used to be one of those terrible people that left the computer running all the time with a dimmed screen or even asleep; it has got that residual power draw, you know. I've got a big 27" screen iMac at home, so that's throwing a lot of power. So after reading one of the challenges last week, I started shutting that down every time I leave the house. I'm sure I'll notice a difference in the power bill so that'll be nice. But I know that it'll make an impact for the rest of us, which is more important to me."

Based upon the evidence found in game logs, survey responses, and interviews, missions in *Greenify* were successful in getting players to change their behaviors in their everyday lives. As getting people to respond to climate change can be a major challenge, this finding demonstrates that an online gamification, social media, crowdsourced approach among a peer group is a promising strategy for prompting behavior change, especially as a part of the gameplay.

### **Theme #2: Changes in attitudes: Increases in environmental awareness and self-efficacy to be able to make a difference as an individual**

When asked if participants "made a special effort to do various actions because of their understanding of climate change" and "know how to take practical actions regarding climate change," they reported 53.8% and 34.6% agreement with these items in the post-survey (respectively), up from scores of just 23.1% and 15.4% in the pre-survey. Further, participants reported that they were far more aware of how their lifestyle and actions impact the environment – from 23.1% (pre) to 46.2% (post). When asked if they believe their actions contribute to global warming and climate change, 88.5% at least somewhat agreed with this on the post-survey, compared to just over three-quarters of participants (76.9%) on the pre-survey. Most importantly, evidence suggests players began to feel empowered, as they reported a new understanding that individual actions can make a difference:

"I think my opinions about the role of individuals has changed. Whereas before I saw the burden of the instituting change falling to big organizations, now I feel like the collective actions of everyone have to, and can be, mobilized to affect big change." (Kylene, female)

"For me, it just opened my eyes to how much energy I consume and waste at home by leaving my monitor on, never looking into residual power draw for equipment I haven't used in weeks." (Mary, female)

"I did them [missions] not just because of the [Tree] points but also because of my own awareness about the issue of climate change." (Heewon, female)

By combining general knowledge with specific actions that people could take, *Greenify* was able to give players a sense of meaningful accomplishment and reduce the feelings of fatalism common to the issue.

### **Theme #3: *Greenify* provides positive peer pressure that leads players to take action, share knowledge and experiences**

Players expressed that being able to share knowledge, ideas, and deeds within a social network was a very positive and motivating experience. When asked about the strengths of *Greenify*, 61% of the players expressed the benefit of social interactions, e.g., commenting on others' missions and deeds. For instance, players said they are motivated when "seeing others' strategies" and "watching others' activity." They found "positive peer pressure" and crowdsourcing aspects to be positive; in the post-survey, players remarked: "The crowdsourcing aspect is great. It gets so many people involved"; "[I enjoyed] learning in *Greenify* [and] seeing other people are learning too"; "it allows being green to become part of a social network"; and "[The game] lets me see how other people I know are doing [actions] to care about this issue."

In some cases, this kind of "positive peer pressure" went beyond the game itself. In her interview response, Cindy (female) talked about how the experience extended into her apartment and to her roommates—people who were not even participating in the online game:

"I think taking the actions and applying them in your actual life makes the game live beyond the computer. I know for myself I've taken some of these action challenges and posted [them] with friends or roommates—so it almost lives in my apartment or in my everyday life and beyond. You know, which kinda makes it fun and kinda engages roommate conversation. So I think it's good kinda talk at recess or talk outside of the game itself on the computer and kind of go 'oh, how did that go for you?' or talk about the actual actions."

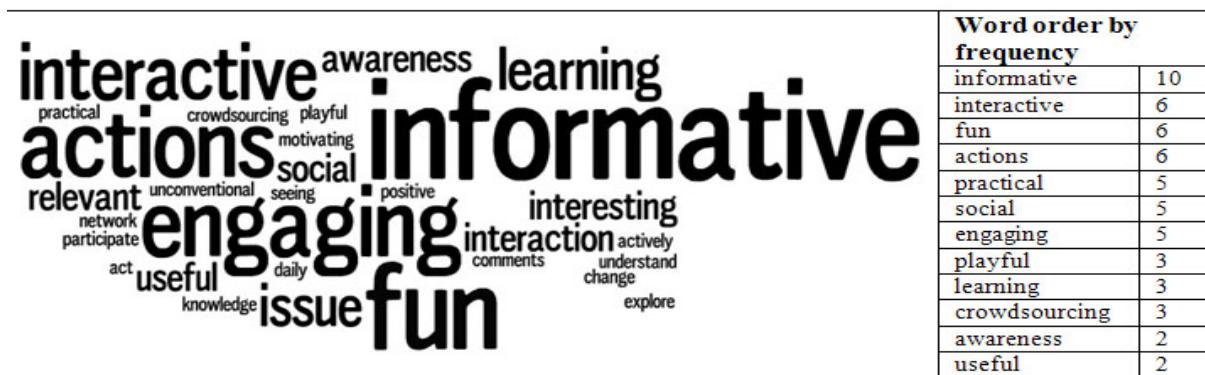
The peer teaching and learning afforded by *Greenify* motivated players to want to teach others about climate change more, from 38.5% agreement (pre-survey) to 65.4% (post-survey). As exhibited in survey responses and interviews, players stated that they discovered the power of collective actions, which changed their opinion about the role and impact of individuals. For instance, Lisa (female) explained:

"I think the real power is just kind of in the interaction. So I've talked to people in the site they have posted links to things or posted articles that I may not have stumbled upon on my own; so I think I've picked up some pretty cool knowledge that I didn't have before."

### **Theme #4: *Greenify* viewed as a unique, effective climate change education strategy**

When asked how *Greenify* compared to other climate change education strategies, students' responses were generally favorable. Lisa (female) remarked: "[*Greenify*] makes it very visual, it makes it very immediate and it makes it very plain. Like you can literally go on to the site, click on an action, click on a mission, and find out what you need to do and what happens in the world as a result of your actions, and I think that's very different than most things you hear. You can watch a video and get told 20,000 different things you should be doing. But this [*Greenify* game] gives you a focus so you can go and focus on one thing that day and make a real change. I think that's pretty powerful."

A frequency-based word cloud based on user responses for "What do you think of *Greenify*?" was produced (Figure 4 below). The most frequently used words were: *informative*, *interactive*, *fun*, and *actions*; followed by *practical*, *social*, and *engaging*. It can be determined that *Greenify* was largely viewed as an informative and interactive experience, consisting of completion of practical everyday actions in a fun and engaging way.



**Figure 4:** Word cloud for “What do you think of Greenify?”

## Conclusions

Following the recommendations of the literature on climate change education, a social, gamification-based website was designed to form an online community engaged in peer-to-peer and action-oriented learning. Evidence suggests that gameplay helped players realize the importance of their personal actions, with reports of new behaviors and an increased desire to educate others on the website and beyond. These findings suggest that: (1) gamification principles are congruent with needed changes to climate change education efforts; and (2) social media technologies can enable peer-to-peer education and can motivate behavior change effectively. Gamification can be a powerful strategy that converts serious real-world problems into engaging and meaningful game play that promotes peer-to-peer education and behavior change through social interactions.

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# Experience Points for Learning: Student Perceptions of Game Mechanics for the Classroom

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**Abstract:** The use of game mechanics to foster engagement in the real-world has been gaining popularity in many fields, including education (Lee & Hammer, 2011). An innovative learning approach was designed for a graduate level course that used some of the most common game features such as experience points, levels, missions, quests, achievement badges, leaderboards, and playable action cards. In this Design-Based Research study, student perceptions of the effects of game mechanics implemented within the classroom on learning and behavior are presented. Implications for educators are also discussed.

## Introduction: Game Mechanics for Education

Game mechanics and elements are increasingly being used in the real world to motivate positive behaviors and increase engagement in a relatively new strategy sometimes described as *gamification*, (e.g., Lee & Hammer, 2011), *motivation design*, or *gameful thinking* (McGonigal, 2011). Game-like thinking and techniques can be applied to formal learning contexts (e.g., Sheldon, 2011) as a way to promote higher engagement, self-directed learning, and a mastery orientation. This seems to be a useful strategy to address student issues of passivity, negative attitudes toward school, and high anxiety that stems from a performance orientation (Bridgeland, Dilulio, & Morison, 2006; Ames, 1992).

While there is much enthusiasm about a “gamified” approach to education, very few studies exist that explore the impact and perceptions of game mechanics when applied to the classroom and how to succeed in adopting more game-like pedagogy. In this paper, the impacts of various game mechanics in the classroom are explored. Findings from a formative assessment are presented, including student perceptions of the impact of game mechanics on their learning. Some implications for educators conclude the paper.

## Game Mechanics for the Classroom: Methodology

A unique class using game-based mechanics to explore potential impact on learning, perceptions toward classwork, behavior, and motivation was designed for an elective graduate level course on the theory and practice of game design for education, building upon ideas from Sheldon (2011). Twenty graduate students (seven male, thirteen female), of which only five identified themselves as “gamers,” enrolled in the course in Fall 2011. In previous years, the course consisted of a traditional syllabus: a student’s final grade consisted of completing weekly assignments from reading textbooks, writing papers, and presenting major iterative individual and group design projects.

In the gamified classroom, everyone began the course with zero “experience points” (XP). Students could earn experience points and level up (Figure 1) by crafting (writing papers), battling monsters (in-class assignments and tasks), mission or task (Table 1): *crafting* (papers), *in-class monsters* (in-class assignments), and completing *missions* (required and optional). Once a certain level was reached, students earned the corresponding letter grade. Students were also placed into guilds (groups) of four, which was used for group missions and various activities.

Grade	F	D	D+	C-	C	C+	B-	B	B+	A-	A
Level	1	2	3	4	5	6	7	8	9	10	11
Experience Points (XP)	0-1000	1000-2000	2000-3000	3000-4000	4000-4500	4500-5000	5000-5500	5500-6000	6000-6500	6500-7000	Over 7000



**Figure 1: Experience Points, Levels and corresponding grades.**

Elements common in popular games were also incorporated into the classroom, including: optional *missions* and *quests*; *collection mechanics* and obtaining virtual currency and other scarce or useful items;

the ability to earn and use *power-ups* (actions) strategically; setting goals and making *meaningful choices*; competing for recognition or top scores on *leaderboards*; and earning and displaying *achievement badges* for accomplishments; team-based collaboration/competition and peer encouragement and support.

Crafting	Battling Monsters	Quests
Avatar assignment – up to 500 XP	In-class Individual Activity – up to 500 XP	Iterative Design Project – up to 2000 XP
Game Play Analysis – up to 500 XP	In-class Group Activity – up to 500 XP	Lightning Design Challenge – up to 1000 XP
Writing Paper – up to 500 XP	Attendance & Participation – up to 500 XP	5 minute optional presentation – up to 500 XP

**Table 1: Examples of Quests and Experience Points (XP) breakdown.**

A custom-designed course website with social networking features served as both as a course management system (with readings, files, online discussions, etc.) and a central hub to track gameplay (e.g., a space where students could see recent achievements earned, student progress, optional mission opportunities, challenges, etc.). A *leaderboard* that displayed the top ten players (those with the most experience points) was regularly updated on the front page of the website for the first half of the semester and a graph plotting total experience points for all twenty students anonymously was used for the latter half of the semester.

Students earned *achievement badges* for making significant contributions and accomplishments. For example, four students were given a *Star Designer!* badge for earning the top number of class votes during group presentations of a design project. Students were also given *Action Cards*, which served as in-class “power-ups” or items that they could use at any time. Depending on the rules specified on the Action Cards, these could be given to themselves or others. For instance, students were given a small number of *Like!* Cards (Figure 2), designed to promote community building and encouragement among peers within the class. When a student ‘liked’ another person’s work or behavior and believed he or she deserves recognition, the student wrote a rationale on the card and gave it directly to the recipient, who in turn turned this in to the instructor.



**Figure 2: ‘Like!’ Action Card.**

Various strategies were used as an attempt to promote a mastery orientation. Rather than emphasizing performance, *making failure acceptable*, was adopted as a game-like principle; students were given the opportunity to redo certain assignments if they were not satisfied with their grade. Similar to Sheldon’s techniques (2011), optional missions were created to encourage further study, deeper participation and self-directed learning. Optional missions available included five minute *Powerpoint* presentations on relevant topics aimed to enhance the course; online discussions and challenges on the course website; proposing new missions to be implemented in class, and participation in relevant research projects outside of class.

## Data Collection

At the beginning, middle and end of the semester, students were asked their perceptions of using game mechanics in the classroom. Using a *Design-Based Research* approach (DBRC, 2003), a mixed-methods study was conducted. An anonymous survey consisting of 7-point Likert scale items and eleven open-ended questions was given in the eighth week of class; a focus group session was held during the twelfth week, and a open response reflection essay was given the final week of class. Anonymity was preserved for the survey in order to solicit honest responses. Thematic analysis was conducted on the qualitative data. Interactions on the course website were also analyzed. Several themes emerged, as will be discussed below.

## Results

### Theme #1: Game Mechanics Perceived as Beneficial for Learning

At first, nearly all twenty students were excited about the idea of using game mechanics for the classroom, as many students used words like “interesting,” “refreshing” and “exciting” to describe the class. After eight weeks in the gamified classroom, students were surveyed on their perceptions of all the game mechanics being used.

All twenty students indicated in their mid-semester survey responses that adding game mechanics to the classroom was beneficial for their learning. Some students reported that the use of game mechanics had a major impact on one’s mindset and behavior, especially compared to traditional courses. For example, one student reported that the classroom culture encouraged learning beyond the minimum requirements set by the teacher and to take risks:

“Traditional grading systems have become quite stale for me. I tend to do just enough to obtain the automatic ‘A’ we all start with and that’s it. With this class, I constantly find myself searching for ways to learn and earn experience points (XP’s)...I find it a refreshing departure from what I’ve done in school prior to this, which honestly hasn’t always been that challenging or rewarded extra effort, creativity or risk.” (Leslie).

Several other responses were similar, citing greater motivation to do work or to cultivate a creative, playful mindset toward learning. Responses included the following:

“The use of game elements is quite motivating.”; “I am starting to see how it can DEFINITELY be of use in a classroom setting.” (*emphasis in original*); “It definitely motivates me...also keeps me engaged.”; “Visualizing the course as a game itself is inherently something that appeals to me, especially as a gamer.”; “It is a lot more motivating than other courses. It makes you really strive to do the little stuff. In other courses you only try to do really well on large assignments..the [game] elements make the classroom dynamic.”

“It seemed like an approach to coursework that I hadn’t encountered before, and I was really interested to see how it would play out.”; “I’ve never seen it in action. The premise behind it is amazing.”; “My experience in class was very positive and stimulating. The gamification of the classroom, in all its aspects, was totally new to me, and extremely refreshing.”

Perceptions of individual game features and their effectiveness for learning were explored using a seven-point Likert scale. The results are shown in *Table 2* below.

Game Mechanics and Elements	Very bad for learning	Bad for learning	A little bad for learning	Neutral	A little good for learning	Good for learning	Very good for learning	N	Mean	SD
Achievement badges	0	0	0	3	7	6	4	20	5.55	1.00
Action cards (e.g. “Like!”)	0	0	1	3	5	4	7	20	5.65	1.27
Experience Points grading	0	0	1	3	4	5	7	20	5.70	1.26
Leaderboards	0	1	4	6	2	6	1	20	4.55	1.39
Making failure more acceptable	0	0	0	1	1	2	16	20	6.65	0.81
Optional Missions (e.g. presentations)	0	0	0	0	2	7	11	20	6.45	0.69
Optional Posts on Website	0	0	0	0	3	7	10	20	6.35	0.75
Propose your own missions	0	1	0	0	0	10	9	20	6.25	1.12
Scarce resources (e.g. obtaining cards)	0	0	1	5	7	3	4	20	5.20	1.20
Guild (team) based competition	0	0	1	2	3	6	8	20	5.90	1.21

**Table 2: Perceptions of game mechanics in the classroom.**

In general, game features were largely seen as good for learning, with *making failure acceptable* ( $M = 6.65$ ,  $SD = 0.81$ ), *optional missions* ( $M = 6.45$ ,  $SD = 0.69$ ), *proposing your own missions* ( $M = 6.25$ ,  $SD = 1.12$ ), and *guild-based competition* ( $M = 5.90$ ,  $SD = 1.21$ ) viewed most favorably.

### **Theme #2: Leaderboard polarizing: viewed as positive for some, negative for others**

The game mechanic that received the lowest average rating ( $M = 4.55$ ,  $SD = 1.39$ ) was the use of leaderboards, a popular element in many social games to foster competition by showing the current top scorers in a game. Initially, the course website had listed the top ten scorers (those with the most experience points) and their corresponding level. Interestingly, its presence was highly motivating for those who were on it, yet highly demoralizing for those who were not. Students on the leaderboard expressed that being on the leaderboard encouraged them to work harder to maintain this status:

"It is [important]. However, when I wasn't on it, I didn't feel as motivated by it. Now that I am, I want to stay there."

"Yeah I like to keep myself in the top tier. It keeps me track and no other class does it. It makes me work harder."

"I find it is making me try a bit harder to stay 'on top' to be truthful. I wish more classes used this method."

However, those who were not on the leaderboard expressed negativity toward it, in some cases describing a sense of discouragement or a desire to give up:

"When I was not on the leaderboard I was tempted to give up and not even try to make it back on!"

"It makes me feel inadequate. I feel that I am putting in much effort...[yet] I am lagging so far behind. ... It is discouraging. It makes me want to give up rather than work harder, though I'm trying to fight that feeling."

"I think making it so explicit how each member of the class is doing relative to each other is generally counterproductive. We want people to learn because they want to master something or get better at it, not so they can feel superior to their classmates."

### **Theme #3: Action Cards promote peer encouragement and collaboration**

Action Cards, including *Like!*, *Creativity*, and *Challenge* cards, were perceived to be an excellent way to provide encouragement and recognition to others and to encourage desired interactions and behaviors: e.g., prosocial helping behaviors, higher quality work, creative ideas and contributions, etc. In total, students handed out over 57 Action Cards to peers. When asked about the value of Action Cards as a limited resource that could be given from student to student, nearly all students praised them highly and discussed their beneficial effects:

"[The Like! card] encourages intrinsic motivation. [It] encourages peers to validate each other...Not only one individual's opinion matters; students, not only teachers, can also contribute to others' grades...I love the Like card. I like that our XP success can be a collaborative effort, and we can do something to help propel our fellow students up that XP ladder. And ultimately, I think acknowledging others' achievements has an even bigger payoff than the more tangible XP."

"[Action cards are a] great way to encourage participation and classroom community! I enjoy complimenting others, so this is a fun way to do that! Also, encourages class participants to be more thoughtful in their work and responses, [leading to] better quality overall!"

"I like it because it helps give me a reason to talk to others. I am shy."

"I do like the 'Like!' card. I received one and it made me feel like I was a part of something and that I had the respect of my course mates."

#### **Theme #4: Autonomy and students taking greater ownership over their learning**

The game principle of *making failure acceptable*, including the opportunity to redo and improve assignments upon receiving feedback, was viewed as valuable for learning and developing skills. Five students (of the eight students who scored the equivalent of 80 percent or lower on a major individual assignment) took advantage of this opportunity, resubmitting improved versions of their papers.

When students were given the opportunity to make meaningful choices and explore relevant topics more deeply on their own, students enjoyed and took advantage of this. Optional missions such as five-minute presentations on any relevant topic of their choice (pending instructor approval) were completed by fourteen students, resulting in a wide variety of high quality presentations including research findings on games and literacy, a survey of teachers' uses of games in the classroom, and even a performance of an original song about the challenges of game design.

Throughout the semester, students were given the opportunity to think metacognitively about their learning processes; students were allowed to propose mission ideas and other game elements to be implemented for the class. Providing students with optional ways to proceed in the course—and thereby greater ownership over their learning—was perceived to be valuable:

"The optional missions and chances to advance are nice...It is motivating. It...doesn't put a cap on things. There are always optional extra credit quests...I absolutely love the ability to do optional quests to gain extra XP."

"I like the variety of optional ways that students can further contribute to the learning community, and I think that would be especially useful in all of my classes."

"The course...[tries] to provide many variations to students for getting grades, not just focusing on fixed assignments that were stated on the syllabus."

#### **Theme #5: Students Still Viewed Gamified Classroom Through a Traditional Lens**

Despite efforts to promote a mastery orientation and remove the focus on grades as a performance indicator, about a third of the students eventually translated the game format into a traditional classroom mentality. For instance, a few students explained:

"Whether you start from 100 or you start from 0, experience points are still grades. People still concern themselves with grades rather than actually doing quests. The point of a quest within a game, is it doesn't matter if you pass it with 1 hp or full hp, you still complete it."

"The leaderboard and XP were sticking points for me. I saw that it made some of my classmates stressed out, because it put more of a focus on grades for them, and others became downright aggressive, wanting to win. Both of those reactions turned me off, and I think they were a direct reaction to the point-based structure of the class."

#### **Discussion**

Students largely felt that the entire experience of a gamified classroom was interesting and innovative. Importantly, several optional missions were completed due to enjoyment of the course and class material even though many of the students had already accumulated more well over 8,000 experience points (well beyond the highest possible level and an A+ grade). Twelve students (60%) also got involved in related activities beyond the class, participating in weekly research meetings to further explore the concepts learned in class.

At its best, gamification has much upside and potential in classrooms, especially in terms of making learning more enjoyable, more self-directed and generating autonomy and collaboration. However, if not designed carefully, side effects and detrimental consequences may occur. Foremost, those designing an in-class gamification experience should promote a mastery orientation and a sense of autonomy before distributing experience points or achievement badges. Optional missions and making failure acceptable were perceived to be valuable and useful for accomplishing this goal. At the end of the semester, students indicated that they wanted more choices and a wider range of missions at the outset to provide greater autonomy.

On the other hand, some game mechanics did not really work. Some students felt that the game layer was simply covering up a traditional classroom experience. Gamification cannot feel manipulative or a superficial covering for traditional school, or else students will lose motivation to learn for the sake of

learning. In addition, game mechanics that led to greater competition, exacerbated by a leaderboard, was not beneficial, as some students expressed increased anxiety and those who fell behind felt a sense of despair. However, students believed a leaderboard could still be beneficial as an opt-in feature, or as a way to display progress on other metrics besides relative classroom performance, such as recent personal improvement, achievement badges or collaborative accomplishments (e.g. most Like! cards for prosocial behavior). The ability to set goals at the beginning of the semester and to see how well one is reaching those goals may be a valuable feedback to provide a self-directed learner. One student proposed the idea of providing "tracks" and "quests" to organize and structure missions, putting them in the context of working towards some larger goal, like becoming an expert on some facet of the subject matter being taught. Class readings could provide general knowledge of the subject and missions could be utilizing that information to explore deeply into some personal interest. One student proposed the idea of unlocking privileges (e.g. the ability to design a new assignment or the opportunity to mentor other students) and new available content, which would add to a mastery orientation. These new ideas and modifications warrant future study to determine their effectiveness in getting students more engaged with intrinsically motivating learning tasks.

There are a number of limitations to this study. Although only small portion of the students identified themselves as gamers (25%), the class was a graduate level game design course, possibly leading to more innovative, game-like approaches to learning by the enrolled students. Students were already motivated as graduate students; further study is needed to see how game mechanics would fare in other courses with different demographics (e.g. urban youth). Another limitation of the study is due to its nature as design research: the generalizability of the findings is limited because of ongoing adjustments made to the design, complexity involved in implementation and confounds in identifying contributors to success.

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# Crap Detection and Information Literacy in the Online Affinity Space of World of Warcraft

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**Abstract:** Information is ubiquitous in today's digital world, and the creation and application of a personal "crap detector" (Hemingway in Manning, 1965; Rheingold, 2011) is imperative to be effective in the information universe. The knowledge communities for online video games offer a place for studying informal and interest-driven learning, as well as the development and use of crap detectors. This study explores the information literacy practices that take place in the *constellation of information*, which is the in-game and out-of-game information resources, of the massively multiplayer online (MMO) game *World of Warcraft* (*WoW*). The study builds a picture of the information literacy practices from the individual to the community and offers a new perspective on how information literacy can be employed to create a better-educated populace.

## Introduction

There is a vast and ever growing web of information available to people with unfettered Internet access. The types of information available are almost innumerable from the local to the global, from the simple to the complex, and everything in between. The information available requires vetting and evaluating to determine validity and applicability for a given situation, this process has been labeled information literacy by some and crap detection by others. Historically, information very often seemed like isolated and static bits found in news paper or journal articles, but today the Internet allows information to be seen and experienced in its connected state. Collaborative and collective activities in interest-driven environments, like those surrounding an online game, are commonplace (Black, 2008; Steinkuehler & Duncan, 2009; Williams, 2006) and present information in a way that shows its connectedness and mutability. The interest-driven nature of these spaces allows for the study of authentic activities that are undertaken by participants within the space as need arises rather than imposed from the outside. Many of the activities engaged in are problems that need to be solved by finding information, which requires information literacy abilities (AASL, 1998; ACRL, 2000; Bundy, 2001). Previous definitions of information literacy focus on traditional forms and settings, like finding information in library resources. They do not take into consideration that information literacy in collaborative spaces does not look like an individual journey undertaken taken by one person but instead uses the collaborative interaction and collective intelligence of a group (Martin & Steinkuehler, 2010). For this paper information literacy is defined as "the intellectual process of recognizing the need for information to solve a problem or issue regardless of setting while working through a process that provides information which fulfills the given need to the satisfaction of the seeker" (Martin, in progress). This definition is flexible enough to apply to many situations involving the application of information literacy practices.

The participants in MMOs and other online interest-driven knowledge communities create a vast amount of resources pertaining to their activity or interest. The conglomeration of resources for one of these spaces, in *WoW*'s case all the in-game and out-of-game resources and methods of communication, which I have termed the constellation of information (Martin, 2011), building on Steinkuehler's (2007) constellation of literacies. Through this study I will explore and describe information literacy in the collaborative online spaces of *WoW*'s constellation of information by examining the research question: What are the forms of information literacy practices engaged by participants in by an online affinity space? Specifically:

- SubRQ 1. How do players identify themselves as situated within the constellation of information available around their affinity space?
- SubRQ 2. How do the forms of information literacy found in *WoW* and its resources compare to previous information literacy research?
- SubRQ 3. How are information literacy practices used by the community to manage major changes in information?
- SubRQ 4. How accurate is the community when using collective intelligence to answer information literacy questions?

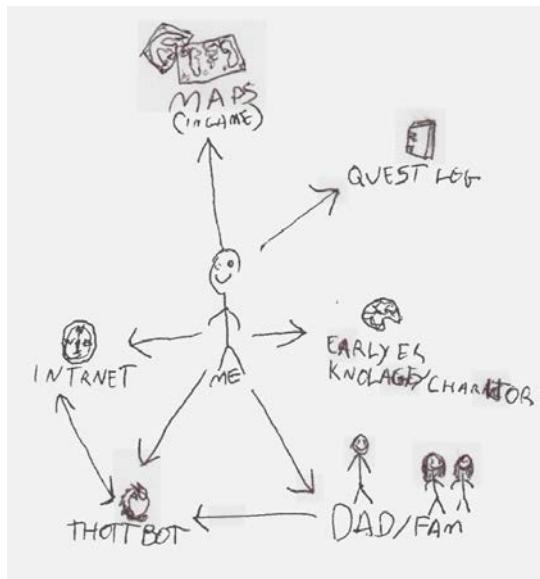
## Methods

This mixed methods study consists of several data collection and analysis methods; all data is related to *WOW* and comes from in-game, out-of-game, and player sources laid out in Table 1. The data collection sources and methods include information horizon maps, structured interviews, chat logs collected through the GLS Casual Learning Lab, and forum posts collected just before the release of the game expansion pack called *Cataclysm*.

Research Question	Data	Analytic Metric
SubRQ 1 Players perception of information literacy in context	Information Horizon Maps & Structured Interviews	Analysis of Maps and structured interviews, using method based on Sonnenwald (1999)
SubRQ2 Comparison of information literacy practices to previous research	Chatlogs coded with an earlier scheme (Martin & Steinkuehler, 2010)	Data will be coded with analytical framework detailed in the analysis section below
SubRQ 3 Information literacy practices during major information change	Forum posts from just before Cataclysm release	Coded using analytic framework
SubRQ 4 Degree of accuracy of information when using collective intelligence of community	Chatlog and forum posts	Compare to Wikis to check degree of accuracy information given in real time

**Table 1: Alignment of Research Questions, Data, and Analytic Metric**

Information horizon maps are a visualization of a player's conception of how they are connected to the information resources in the constellation of information of their game. The participant is asked to draw a map or picture of how they are connected with resources that they use for information within the constellation of information, which can include wikis, forums, websites, people, etc. The participant is then asked to describe the information horizon map including what order or in what situations they would use each source. Figure 1 is an example of an information horizon map from a participant in the study.



**Figure 1: Information Horizon Map for John, who is 14.**

The chatlogs were collected from *WoW* using the text command “/chatlog” will record chat on all channels to which the players have access. These chat logs were collected during lifeguarding

sessions over eight months of data collection in an afterschool lab of adolescent males (Steinkuehler & King, 2009). All chat channels from these chat logs will be considered in analysis because all parties agreed to be recorded or the chat is from public channels. The reason for inclusion of these previously collected chat logs is because they have been coded for information literacy practices previously and analyzed in Martin and Steinkuehler (2010) to create a framework for information literacy. The inclusion of this data will allow for comparative analysis, which will be described in the next section.

Forum posts have been collected for this study, as well. The *WoW* forum of Reddit, located at <http://www.reddit.com/r/WoW/>, was chosen for the data collection because the posts are voted on by those who participate and therefore questions chosen as worthwhile by the participants in the community come to the top of the list. It attracts a wide range of participants in both experience and skill. The forum posts were collected over a period of two weeks using purposive sampling. The range of time coincided with the period just before the release of the *WoW* expansion pack *Cataclysm*. This time period was chosen because the affinity space's participant created information resources were on the verge of becoming obsolete due to the upcoming major changes to the game. During this time period the participants were in the process of triaging what was going to change and how. Capturing this data gives a perspective on what the rebuilding process of information resources for an established community looks like.

## Data Analysis and Findings

The overall analytic framework for this study is being referred to as analytic description. Analytic description<sup>1</sup> is a mixed methods analysis that illustrates transforming qualitative data into numbers and coupling that with qualitative description. The transformation of qualitative data into numeric form has been referred to by Chi (1997) as quantifying qualitative analysis. Analytic description is a quantifying of qualitative data; the processes use methods like counting codes to create numeric values, which can be used to create percentages or graphs and charts. The numbers are just descriptions of the qualitative data used to represent the data in a more understandable way, and are usually used to give a more broad scale view of the qualitative data set. For some parts of this study analysis is ongoing, in those situations initial findings are presented.

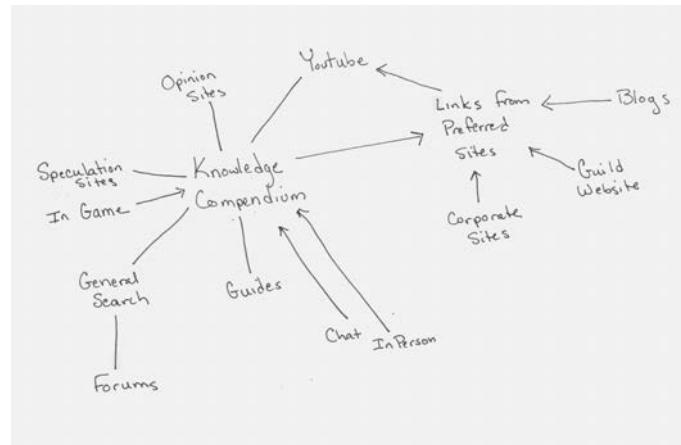
## Information Horizon Maps

Analysis of information horizon maps was carried out to look for patterns across participants maps. Of course, each information horizon map was unique. Each participant located himself, all participants were adolescent males, on the map and then drew the information horizon around this location, or in any orientation he saw fit. To analyze the maps, a matrix was created (Sonnenwald, 2005). The matrix consisted of the participants functioning as the columns and the information resources the participants include in their maps as the rows. The identification and inclusion of all information resources was important for the analysis. Then the matrix was populated by numbers denoting the order in which the participant would use the sources on their individual map. If necessary, categories could be created to handle types of individual resources. For example, a category named forums could be created and include all mentions of forums instead of including the individual forum names.

Resource	Noel	Nick	Neil	Aidan	Brandon	Roger	John	Walton	# Students
Knowledge Compendium	1	2	1	3	1	3	2	1	8
Forums		2				4			2
Corporate Site		2							1
Guild Websites			2						1
General Search		1			2	1	3		4
Speculation Sites	4								1
Guides	2								1
Opinion Sites	3								1
Chat						5			1
In-Person				2		2	1		3
Strategy Guide		4							1
links from preferred sites		3							1
In-game resources				1			4		2
blog								3	1
Youtube								2	1

**Table 2: Aggregated resources by participant (pseudonyms have been used)**

A master map was constructed from the table. The master map is a conglomeration of the resources and the connections between them, and can be seen in figure 2.



**Figure 2: The master map of the information horizon maps**

The participant is, of course, connected to all of these resources but is not included visually on the map because it creates visual clutter. As can be seen in the master map and the aggregated resources table, knowledge compendiums, like wikis, are the resource that the participants in this group turned to most frequently and were the only group of resources that every single participant drew in their map. As can be seen by table 2 half of the participants listed this as their first information resource consulted. Viewing people as information resources varied from participant to participant, with some considering other people as a source to find needed information. The younger participants were more likely to ask family or friends when they were stuck and needed information, whereas, the older participants varied and usually asked other people only after trying to find the information themselves. Neil, who is an expert player, specifically mentions the fact that he only uses his own guild as a last resort for finding information because he does not like to interact with people directly and prefers asynchronous sources in which he can feel more removed. These variations in asking for information as opposed to finding it oneself show a variations in identity, just as in the example of Neil, he identifies as a very independent player and therefore tries to avoid making his information needs known to others.

## Coding

Coding was a major component of the data analysis. Both a priori and emergent coding were undertaken within the data set (Saldana, 2009; Chi, 1997). Turn of talk was the chosen unit of analysis for both the forum and the chatlog data. NVIVO was used as the qualitative analysis software. The coding scheme was developed based on a framework developed from previous research (Author, in progress). This framework was developed through an analysis of existing information literacy definitions, to build a larger model that covered the information literacy process. The non-linear interconnectedness of the framework is based on my past work (Martin & Steinkuehler, 2010) that demonstrated that the process of information literacy varies depending on the situation and a linear model does not address this. This framework produced an a priori coding scheme of ten codes. The codes and their definitions can be seen in table 3.

<b>Code</b>	<b>Definition</b>
<b>Recognize information need</b>	To recognize needed information for a particular problem
<b>Identify information needed</b>	To identify information and resources that are necessary to fulfill the information need
<b>Construct strategy</b>	To construct a strategy in order to locate and access needed information to fulfill the information need
<b>Determine extent of need</b>	To determine the extent of information needed to fulfill the information need
<b>Organize Information</b>	To organize retrieved resources and information for later use
<b>Disseminate information</b>	To disseminate information to others who have an information need or as a way of sharing results of the information literacy process
<b>Construct New Concepts</b>	To apply prior and new information to construct new concepts or understanding
<b>Evaluate information and source</b>	To evaluate information both for its applicability to fulfill the information need and the reliability of the source itself
<b>Access needed information</b>	To access needed information
<b>Use information effectively</b>	To use information effectively to fulfill the information need

**Table 3: A Priori Codes**

This coding scheme is being used to code chat logs gathered in the afterschool lab. The reason for applying this coding scheme is to allow for cross comparison between two information literacy frameworks. The data was originally coded using a framework based on the Catts & Lau (2008) definition of information literacy used by Martin & Steinkuehler (2010) in their article *Collective information literacy in massively multiplayer online games*. The coding scheme applied by Martin & Steinkuehler can be seen in table 4. The purpose in recoding this data is to allow for a comparative analysis between the two sets of codes. Intercoder reliability is at 99% for 10% of the total data corpus. So far in this analysis disseminate information and recognize information need are highly used codes, just as seeking information and disseminating information were in the Martin and Steinkuehler study.

Hatha: What exactly are the daily quests? –Recognize Information Need  
 Deathndoum: quests u do evrey day at lvl 70 for gold – Disseminate Information  
 Hatha: Mkay.  
 Hatha: Just gold? –Recognize Information Need  
 Deathndoum: mhm – Disseminate Information  
 Hatha: Nice

A new code, casual information, was also necessary as coding has progressed. This code captures interactions of being players that do not require in depth information seeking and problem solving. Moments like asking another player what are they doing that night in the game, or asking another player about day to day out of game things (e.g., is it snowing where you live?). Although these are questions and they do require information to answer them they do not have the substance of an actual information need. So far the 'code organize' information has not been coded at all, which was expected and the code will be removed from future iterations of the coding scheme if this remains true.

<b>Code</b>	<b>Definition</b>
<b>Seeking Info</b>	To locate relevant information for the task at hand.
<b>Evaluating Info</b>	To evaluate the reliability and credibility of different information resources.
<b>Interpreting Info</b>	To identify significant information from less significant information, determine or infer its meaning, and draw appropriate and meaningful conclusions from it.
<b>Synthesizing Info</b>	To combine information from multiple resources into a coherent whole.
<b>Disseminating Info</b>	To seek out and use appropriate distribution channels for one's own info production.

**Table 4: Coding scheme from Martin & Steinkuehler (2010)**

The collected forum posts are another part of the data that is being coded with the analytic framework discussed above. Emergent coding is utilized here because of the context in which the forum posts were captured. So far in the analysis of the forum posts disseminate information and recognize information need are both prominent codes. However, evaluate information and source is also a very frequent code, in the context of forum posts this manifests itself through those participating in the discussion evaluating the information provided by previous participants. In this data set the emergent code, unrequested information, has been employed to track situations where information that is outside the scope of the question is named as such by others in the conversation. An example of this would be a person asking a question as to whether Affliction or Destruction is the best spec for a Warlock. The question garnered a variety of answers, which are coded for Disseminate Information, including this one:

For leveling, go with affliction to start with; once you hit thirty and can dual spec, you can pick up destro. I went with demon for the off-spec, because I found the utility of being able to easily solo elites with metamorphosis useful while leveling through BC (the 10% spellpower buff was also nice.) You've mentioned that you'd prefer not to go that route, but you should do well as afflic/destro. Just use afflic to quest and go destro to wreck elites in instances.

However with the helpful answers there were also people who kept suggesting Demonology despite the fact that the person asking the question said that he was not interested in Demonology. This was unwanted information and the person who had originally asked the question repeatedly said to those offering Demonology as the best option that he was not interested in this path. However, after one person gave a very detailed and specific reason why they preferred Demonology the person who posed the question showed interest and asked for further explanation. The asynchronous nature of forums offers a different communication pattern than that of synchronous in-game chat.

### **Collective Intelligence Analysis**

Analysis of the effectiveness of collective intelligence was conducted on the forum posts. The forum threads were coded for the type of statement that each post was. The codes include Answer, Incorrect Answer, Acknowledgement, Agreement, Subversive, Superfluous, and Question. In the first 15 forum threads 263 answers were given to 31 different questions, multiple questions were sometimes asked in a single thread. Only four of those answers were incorrect and all were corrected by the community. Answers to questions were the majority of the 394 posts. However, there were 70 posts that were completely superfluous to the conversation. This was vastly more than posts that were intentionally subversive; only two posts were coded as Subversive from the first 15 threads. This means information literacy is being applied at the group level, evaluating each post to determine validity. It also takes information literacy skills at the individual level to determine what information is superfluous or subversive and therefore of no real value. The collective intelligence of the *WoW* community is proving to be accurate and efficient at self-correcting when information is given that is incorrect. This makes the collective intelligence of those interested in *WoW* an accurate and useful resource for others in need of information on the same subject.

### **Conclusions**

Overall this study will develop the analytical framework for information literacy practices in online affinity spaces. Beyond this, this study will help to describe the information literacy practices of the *WoW* community. The analysis demonstrates that players in the *WoW* community use a variety of information literacy practices in order to solve problems and answer questions about their game play. The level of complexity of the information literacy practices used depends greatly upon context in which the question is asked. If asked in a synchronous format, players are usually looking for information that has come up spur of the moment and can be answered in a succinct way. If asked in an asynchronous format, players have the luxury of asking more in depth questions that require longer answers and that utilize a more complex information literacy practice. The individual player matters as well in how and where they will ask for help. As seen from the information horizon maps, a player's identity influences what they consider to be resources available to them and how they approach those resources. Finally, the collective intelligence of the *WoW* community offers a high degree of accuracy and self-correction making it a reliable source for information. Together these four sub-research questions help to illuminate the forms of information literacy in an online affinity space like *WoW* as well as to fill a gap in information literacy research on what types of practices are engaged in by participants in these online communities. Using this research as a foundation for

change, a process that guides people to become lifelong learners and better informed citizens can be built that takes into account people's natural practices and the work communities like WoW already achieve.

This study offers a hitherto unseen look into information literacy practices in a natural and leisure setting. The significance of this work beyond studying information literacy in a new setting is that it is trying to determine the practices that people actually employ related to information literacy. The study offers the chance to work through a framework based on existing literature to determine its applicability, since many of the previous standards and frameworks have been created top down. From this study corrections to the framework will be made, honing the terms based on the practices. The framework as a part of this larger model of information literacy when fully developed will help to predict the information literacy practices of participants in affinity spaces and eventually beyond. The more affinity spaces like the WoW community which are studied, the more stable the framework should become, eventually leading to a larger predictive model, in which a change in parameters will result in a predictive change in outcomes. This framework differs from some of the previous models of information literacy moving use of information to the culmination of the process; this presents a chance to see a process ending in information use. A major implication of this study is that it does not present information literacy as a scarcity model. It is based on the assumption that information literacy practices are enacted by people all the time, people with sophisticated information literacy practices can detect crap. As well as the assumption that people can have individualized information literacy practices, a personalized crap detector, that they use to help them successfully fulfill their information needs. This change in perspective is a departure from the idea that everyone needs to be taught to utilize the same strict structure of information literacy. Over time, this research can influence the way information literacy is utilized as a building block of education.

## Endnotes

- (1) Analytic description is a method of analysis that Constance Steinkuehler uses to describe her analysis method when presenting her work and was suggested to me by her. The term does not appear in any of her publications to date, so this footnote is being used as a method of citation.

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# Game Presence and Literacy: A Methodology Refined

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**Abstract:** We present the newest and most rigorous iteration of a game-play methodology that analyzes the focus of MMO game players for *information flow*, *physical self*, and the virtual *game world*. In examining the three (emergent) threads of what we are naming *presence*, we are able to provide a coherent account of game play that does not fall prey to the false dichotomy of “real” and “virtual.” We will share the results from our research, and provide detailed methodological information so that others can learn and adapt our process to their needs.

## Introduction

There is a growing body of research on massively multiplayer online games (MMOs) or virtual worlds as literacy (Gee, 2003; Steinkuehler, 2007; Black & Steinkuehler, 2009) with compelling evidence suggesting that such sociotechnical environments foster sophisticated intellectual practices across a variety of domains, including science literacy (Steinkuehler & Duncan, 2009), advanced reading comprehension (Steinkuehler, Compton-Lilly, & King, 2010), and information literacy (Martin & Steinkuehler, *in press*). However, research to date focuses on the distinction of “online” and “offline,” “virtual” and “real,” and does not explore the experience as a whole, as Leander calls for (2003). Contemporary literacy research recognizes that time and space are experienced in interconnected ways and that these concepts are entwined and ensnared with literacy practices. Gaming as a literacy practice is no exception. While time and the experience of time in games have been studied by a handful of researchers (Chen, 2007; Juul, 2004; Myers, 1992), we have no theoretical model of gaming as literacy in terms of space and time. How might gaming as a virtual literacy be reconceptualized in ways that provide a more complete account of actual practice, taking both time and space into account?

Capturing the many activities that take place in the game play of a person in a massively multiplayer online (MMO) game is complex, and yet an incredibly important task for scholars who wish to deeply examine their actions and interactions. Over the past three years (and counting), we have gathered ethnographic data (participant observation, multimodal fieldnotes, interviews with informants) and exploratory assessment data (reading assessments of both gaming artifacts and individual gamers) in order to better understand the ways in which gaming is caught up in a complex web of myriad forms of semiotic work. These data have focused primarily on the massively-multiplayer online game (MMO) *World of Warcraft* (WoW), selected given its singular success on the computer gaming market, and have included both adolescent and adult participants at varying stages of expertise. Based upon this experience, we have developed a new method that captures both the literacy practices and what we have called the *presence* or *focus* of the player. This *presence* involves the three interwoven spaces of the *virtual game*, *physical body*, and *information flow* or access.

## Background and Theory

In previous reports (Martin et al., 2011; Martin et al., *in press*; Williams & Martin, 2011a; Williams & Martin, 2011b), we have shared our budding methodology for visualizing the presence of the player, and how it serves to pinpoint the actions of the player across different areas, allowing for the tracing of resources used and a fuller description of the information literacy practices required to be an expert player. This paper outlines previous iterations and extends the methodology.

Researchers have consistently had difficulties with understanding the engagement of MMO players, particularly because of the persistent tradition of an offline/online division. We have taken a different tack altogether, characterizing players as shifting in *focus* rather than *self*. In this paper, based on this data corpus, we reconceptualize MMOs as a literacy space, and gaming as traversal through that space. We describe our theoretical framework in three parts. First, we divide the topology of MMO engagement as three major threads: the player-personalized flow of information (such as wikis, guild websites, verbal communication via voice-over IP resources, and user interface modifications); the physical space and body-based interactions or needs (such as interacting with others in the same geo-location, or taking a break to prepare a meal); and the real-time present (albeit digitally mediated) interactions in the virtual space itself (with other players, such as raiding or arena battles; or with the

game itself, such as through battling monsters or using the in-game calendar). With this theoretical conceptualization in place, we then characterize gameplay as traversal of this literacy space, movement in which the “game” acts not as content but as impetus, agent or driving force by creating moment-to-moment content deficits for the player that motivate “reading” and, ultimately by end-game state, “writing.” Under these terms, a player’s location of focus is the primary context that determines traversal of the literacy space, prompting us to question the distinctions we typically draw between the global and the local, contextualized versus decontextualized text, and concrete versus abstract.

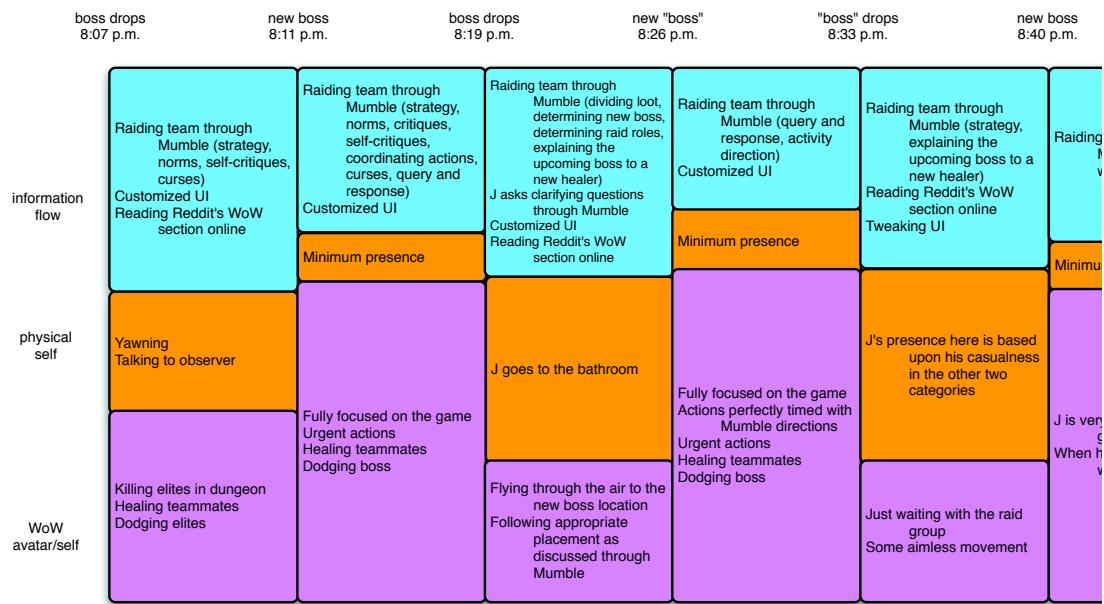
A powerful influence on the development of our methodology was Gell’s (1992) characterization of time. Gell posited two different types of time: A-series time is time as measured by a clock; and B-series time is based upon the natural punctuation or rhythm produced by and with the activity. Gamers live in a hybrid space where both A-series time and B-series time are important and must be attended to (Martin, in progress). For example, a WoW player attends to B-series time by following the pattern of gameplay: fighting when there are enemies to fight, and stopping fighting when the enemies are dead or gone. On the other hand, the player must also attend to A-series time to make it to dinner, work, or school on time.

## Methodology

We outline our previous iterations of methodology, and then discuss our current data collection and planned analysis.

Through our initial data collection and analysis, we found three loci of *presence*: *information flow*, *physical self*, and the game itself (labeled in Figure 1 as *WoW avatar/self*). We coded anything as *information flow* that involved seeking or modifying information: for example, customizing a user-interface (UI) so that the default information received from WoW is changed would be considering *modifying information*. Another frequent example of *information flow* involves the player going online to seek out tips from other players on game-related websites. We used the code *physical self* whenever an activity occurred that drew the player’s focus from the game to the physical realm: the jumping of a cat in front of the screen, or perhaps a bathroom break. Finally, we coded *WoW avatar/self* to account for the in-game activities taking place. By coding and annotating these three themes of presence, a holistic account of gameplay is reached.

As reported elsewhere (Martin et al., 2011; Martin et al., in press; Williams & Martin, 2011a; Williams & Martin, 2011b), the analysis method originated with the collection of data through observation while each participant is engaged in game play. The researcher took detailed notes of where the presence of the participant is most focused, as evidenced through their various activities and levels of engagement. For example, our primary subject is Jais, an expert player in WoW who belongs to a top-ranked raiding guild server-side and internationally. Jais tends to be primarily focused in the game when he’s actively participating in a raid; however, different types of participation in WoW often result in different distributions of focus. For example, if he’s working on his professions, Jais frequently consults online information resources in order to maximize his profession-leveling efficiency, and also often has television on in the background. His presence then is distributed more heavily into the physical presence and information access channels, and only minimally in the WoW virtual space. Our analysis resulted in presence visualizations (sample given in Figure 1; note the B-series and A-series time stamps in the top row).



**Figure 1: Sample of a Presence Visualization.**

Each presence visualization tracks Jais' focus of the three different distinctions. Note, however, that although our prior method of collecting data (through field notes) served its purpose for the initial stage of development, the clear next step in the refinement of our presence examination requires more precise data. To that end, we are collecting additional expert WoW player data this spring, using the technology of Silverback (<http://silverbackapp.com/index.php>) to capture both the game screen and the participant's face, as well as a video camera focused on the participant and his surrounding area. Transcription of this rich data will be conducted with Transana ([transana.org](http://transana.org)), a qualitative analysis software that permits simultaneous viewing of both the Silverback-produced video and the video camera data. It will necessarily include time stamps of the participant's general eye-gaze, so that we can more accurately operationalize focus (keeping in mind, of course, that eye gaze does not account for everything, such as audio information exchanges and frequency of digital movement as measured through keyboard engagement rates). Our analysis will include a more rigorous account of presence, by examining details that are not as clearly captured in field notes.

Given that our results will not be available in time to be included in the proceedings, we will post our presentation online following the conference so that our full results are easily available.

## Conclusion

We hope to contribute to the conference conversation by offering a new and rigorous methodology. Basing it upon our prior methodological design work (Williams & Martin, 2011a; Martin et. al., 2011; Martin et al., in press) and upon our engagement with an extended data corpus culled from MMOs, we provide a way to examine video game play with new conceptualizations of space and time that do not fall prey to false but attractively simple binaries like “virtual” and “real.” Our full presentation on the most recent iteration of this methodology, once completed, will be posted at <http://therealca.ro/GLSpresence.html>.

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# Information literacy and online reading comprehension in WoW and school

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**Abstract:** Massively multiplayer online games and affinity spaces offer a vast array of literacy practices and reciprocal apprenticeship (Gee, 2003; Steinkuehler, 2007; Black & Steinkuehler, 2009; Black, 2008). Many of these literacy and learning practices are well researched (Steinkuehler, 2011), however, the practices of online reading comprehension and information literacy processes are nascent in terms of research. This study was originally designed to compare the online reading comprehension skills used in schools and games; however, this analysis proved to be unfruitful because both tasks were imposed query (Gross, 1995; 1999). This data set does give us an interesting opportunity to compare two coding schemes that both look at how people find and use information.

## Introduction

Literacy learning is a naturally occurring and pervasive part of massively multiplayer online games (MMO) and affinity spaces (Gee, 2003; Steinkuehler, 2007; Black & Steinkuehler, 2009; Black, 2008). Sophisticated practices using science literacy (Steinkuehler & Duncan, 2009) and advanced reading comprehension (Steinkuehler, Compton-Lilly, & King, 2009) have been documented in online discussion forums and fandom texts related to MMOs outside the context of school and other traditional learning spaces. These communities function as participatory cultures (Jenkins, 2006), with community members both producing and consuming information in equal turn. The production and consumption cycles of participants are collaborative and leverage the intellectual resources of the community in a way similar to that described by Levy's (1997) theory of collective intelligence. These communities in and around MMOs also function as communities of practice as described by Lave and Wenger (1991); they offer information to members and use apprenticeship to help new members learn the standards and practices valued within the community (Steinkuehler, 2004). The collective intelligence and communities of practice aspects of these communities are seen not only in written documentation of the community of an MMO or affinity space like a wiki, but also in in-game chat. The information needs of the individual seeking information in this setting require both the collective intelligence of the community to give the individual not only an answer but to give the correct answer, as well as be willing to apprentice novices, which is a core value of communities of practice.

## Theoretical Framework

### Online Reading Comprehension

The study of how people read and comprehend online reading materials, online reading comprehension is considered to be a part of literacy studies. Leu, et al., (2001) viewed online reading comprehension through the lens of new literacies, framing it as problem-based inquiry which requires the person implementing online reading comprehension to have new skills, strategies, and dispositions on the Internet. These new skills, strategies, and dispositions allowed the user to create questions that were driven by interests and information needs that occurred while reading. The reader then needs to locate, critically evaluate, synthesize, and design and communicate possible solutions to these questions. Leu and Zawilinski (2007) reaffirmed the list of skills needed for online reading comprehension by determining there were five major functions of online reading comprehension: 1) developing important questions, 2) locating information, 3) critically analyzing information, 4) synthesizing information, 5) communicating information. The functions of online reading comprehension show strong similarities to information literacy; these similarities are explored below.

The differences between studying reading comprehension of print-based media and digital media were laid out by Coiro (2009). First, students needed a new and different skill set to successfully read online. These included creating search terms, sifting through sources, making evaluative choices, synthesizing the chosen sources, and responding through digital communication. The second difference focused on the disposition of the student toward the Internet, with high performing readers

displaying persistence, flexibility, and skepticism. The third difference between digital and print reading was that students often looked for information in a collaborative way on the Internet; they work together in-room, use synchronous online communications methods like gchat, and utilize asynchronous online communications like forums, or collaborative sources like wikis. The fourth difference was that the process of reading should inform the instruction of reading. Coiro found that many struggling students only accessed the top link of a page of search results; often gave up if they could not find information easily; retyped URLs because they were unaware of copy and paste; and typed whole questions into the address bar and added .com at the end. The fifth difference was that the nature of online reading comprehension was constantly changing as digital tools change. The argument being made here is that online reading comprehension is different than traditional reading comprehension. Online reading comprehension requires the ability to read in a format that may not be linear; links within in the text may be explored at any time moving the person away from a straightforward and linear path. Coiro studied participants reading non-fiction and reference materials. The ability to switch to a related subject highlighted by a link is just one of the ways that reading online is a more fluid and complicated, process.

### **Information Literacy**

Traditional information literacy theories and standards are designed to describe the practices of information literacy in formal learning environments like K-12 or college (AASL, 1998; ACRL, 2000). Many traditional models are unable to account for some of the most basic practices in online affinity spaces, such as *World of Warcraft* (*WoW*). These spaces have little in common with traditional resource-heavy spaces. The traditional models focus on formal educational settings using institutionally created information resources utilized by a single person on a solitary journey, with the output of their search usually ending in a paper. The online affinity space is collaborative and the resources vary from institutionally created (resources published by the game companies) to a variety of user-created resources such as leveling guides, guild websites, and wikis. Because so many of the resources are user-created, the nature of the resources is constantly shifting, with the information they present constantly in flux. Thus, we need a more contemporary framework for information literacy skills that can better account for the collaborative nature of communities like those found in the information constellation around *WoW*.

Information literacy is more than just a skill set. It requires reasoning and critical thinking skills for determining which sources and information best fill the need at hand. It requires both ICT (Information, Communications, and Technology) skills and critical thinking because it encompasses both. Using examples culled from eight months of online ethnographic data (Steinkuehler & King, 2009), Martin and Steinkuehler (2010) have examined the information literacy practices that arise in the in-game chat of *WoW*. The information literacy practices observed in analysis take the form of five patterns. These patterns were identified and described in Martin and Steinkuehler (2010) as “call and response”, “call and refer”, “call and avalanche”, “simultaneous not sequential”, and “fluid”. These new patterns utilize the existing descriptions of the process of information literacy but crucially illustrate the actual actions and practices of people in natural information seeking spaces.

### **Methods**

This study was designed to replicate and build on a study conducted by Coiro and Dobler (2007). Their original study followed 11 successful 6<sup>th</sup> grade readers of mixed gender as they completed two tasks of online reading comprehension. The first task required participants to use a website about tigers to find information and determine answers for a set of seven comprehension questions. The second activity was structured similarly except that the students were able to use the website Yahoolagains!. During both activities the participants were asked to think aloud about their process. From the data collected, Coiro and Dobler coded the transcribed think-alouds to determine the practices that readers with a high reading ability in traditional reading settings use in online reading situations. We conducted a modified version of the study. The study took place in part of an afterschool lab for adolescent males, 13-18 years old and mostly from rural areas, conducted at University of Wisconsin-Madison. The lab ran for two years with a pilot in 2008 that had 9 participants and the full lab running in 2009 with a total of 22 participants. Most participants were considered chronically disengaged with school and were identified as struggling readers. The lab met face-to-face once per month and regularly online in *WoW*. A modified version of the original Coiro and Dobler study was conducted during a Saturday face-to-face meeting. The main modification to the study was that a reading in the form of a wiki pertaining to *WoW* was substituted for the Yahoolagains! portion of the original study. One activity, referred to as “Tigers” for our research, used the Save the Tiger Fund

website; this is the same website that Coiro and Dobler used in their original study, which at the time was called 5 Tigers: The Tiger Information Center. The second activity, which we refer to as "Murlocs", used the Murloc WoWWiki.com page. WoWWiki.com is a wiki similar to Wikipedia, but dedicated entirely to articles about *WoW*. This site was used in conjunction with the website Save the Murlocs.

Both activities, Tigers and Murlocs, included worksheets that asked seven comprehension questions: five content questions and two inferential questions. The participants were asked about their levels of prior knowledge and interest in the topic before each activity, and about their enjoyment of and success with the activity after they had completed it. These activities required the participants to use the designated websites to answer the questions while thinking aloud to explain their actions and decision-making. The think-alouds were videotaped, transcribed.

## Analysis & Results

The data analyzed in this study was a combination of the results from the worksheets from the Tigers and Murlocs activity as well as analysis of the think-alouds. The think-alouds were analyzed using two a priori coding schemes, Coiro and Dobler's (2007) coding scheme and Information Literacy.

Analysis of the worksheets rendered the information in Table 1. While prior knowledge for the Tigers and Murlocs activities had a mean of less than three, which on a five-point scale is less than 50%, both mean comprehension scores were over 70%. Thus, although prior knowledge was low, participants were still able to find correct information with reasonable success.

Reading Tasks	Response	
	Mean	Range
Prior knowledge about tigers <sup>a</sup>	2.2*	1-3.5
Interest in Tigers <sup>a</sup>	2.63*	1-4
Enjoy Tigers task <sup>a</sup>	2.6*	1-3
Success at Tigers task <sup>a</sup>	3.267*	1-5
Comprehension questions answered correctly <sup>b</sup>	4.967*	1.25-7
Prior knowledge about Murlocs <sup>a</sup>	2.5*	1-4
Interest in Murlocs task <sup>a</sup>	2.63*	1-5
Enjoy Murlocs task <sup>a</sup>	2.99**	1-4
Success at Murlocs task <sup>a</sup>	3.89**	1-5
Comprehension questions answered correctly <sup>b</sup>	5.183*	3-7

\*N=15 \*\*N=14  
<sup>a</sup> Participants chose rank on a scale of 1-5, with 5 being the highest  
<sup>b</sup> Total correct out of 7 questions; participants may not have completed all questions

**Table 1: Screenshot of WoWWiki Murlocs Website.**

Average scores across all measures were slightly higher for the games-related reading, but not high enough to be statistically significant. In Table 2, a sample of the participants' most recent grade in English is compared to their success on the worksheets. Participants' strategies for finding information and comprehending online texts were of central interest to our design.

Participants*	Grade Level	Grade in English	Tigers Score	Murlocs Score
Jamie	11	A	71%	86%
Wes	12	A	100%	100%
Nicholas	11	B	86%	71%
Neil	8	F	57%	71%
Alex	7	B	89%	86%
Patrick	9	B	71%	86%
Jay	7	C	71%	46%
Jesse	10	A	79%	86%

Derrick	9	D	18%	61%
Noel	10	A	79%	86%
Brandon	11	C	71%	75%
Todd	8	A	86%	100%
Christian	7	A	79%	57%
Zach	7	B	71%	57%
Connor	12	C	43%	43%

\*Pseudonyms have been applied for this paper

**Table 2: Comparison of participants' last grade in English to succeed on worksheets.**

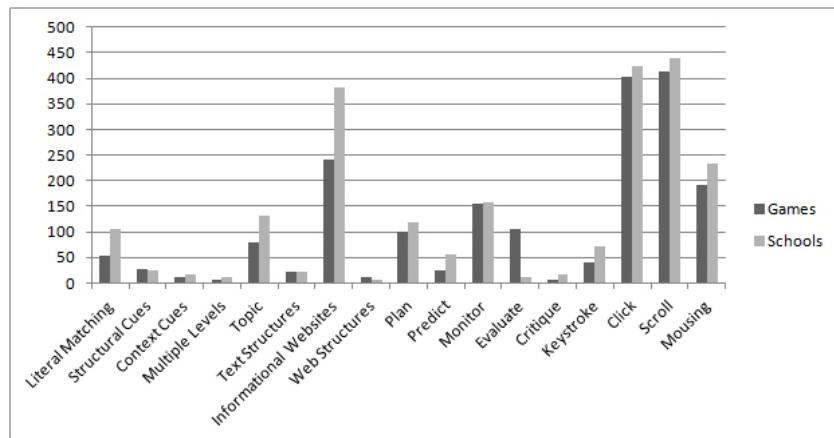
### Online Reading Comprehension

A coding scheme, similar to Coiro and Dobler (2007) (see Figure 1), was structurally altered from the original scheme in two ways: (1) a code to track when participants were critiquing the activity, and (2) a code to track mouse movement. The code for Prior Knowledge Search Engines was removed due to the fact that the study had been modified to exclude search engine activity.

Coiro Dobler Coding Scheme	
Category	Definition/examples
<b>Inferential Questions</b>	
Inferential prediction (IP)	Makes, confirms, or adjusts a substantiated guess about what will come next, usually prior on clicking a particular link
Inferential prediction informed by literal matching (IP - LM)	Uses the words in the search question and seeks similar words within the hypertext to inform prediction about where information might be found
Inferential prediction informed by structural cues (IP-SC)	Makes connections between the way the website is organized and the type of information needed to inform prediction of where information might be
context cues by context cues (IP-CC)	Makes use of the descriptions, icons, graphics, and headings to inform prediction about where information might be found
Inferential prediction informed by anticipations across multiple levels(IP- ML)	Makes use of understanding that information may be "hidden" beneath several layers of links on a website to inform prediction about where information might be found
<b>Prior Knowledge</b>	
Prior Knowledge of the topic (PK-T)	Relies on domain specific knowledge and key vocabulary to inform reading choices
Prior knowledge of informational text structures (PK-ITS)	Uses knowledge about the ways informational text is organized on a website (e.g. titles, headings, description, captions) to inform reading choices
Prior knowledge of informational websites (PK-IW)	Uses ability to recognize and negotiate hyperlinks, navigational icons, interactive multimedia, and browser toolbars to inform reading choices
Prior knowledge of search engines (PK-SE)	Draws from experiences with the processes of browsing, selecting appropriate search engines, formulating keyword searches, negotiating subject hierarchies, and evaluating annotated search results to inform reading choices
Prior knowledge of website structure (PK-WS)	Uses ability to recognize the general structure of specific websites to inform reading choices
<b>Self-regulation</b>	
Self-regulation: Plan (SR-PL)	Thinks about multiple choices, sets a purpose, and prepares a plan of action that addresses questions such as: What do I need to find out? Where should I begin? Where do I want to go? What do I need to do first?
Self-regulation: Predict (SR-PR)	Makes, confirms, or adjusts a substantiated guess about what will come next, usually prior to clicking on a particular link
Self-regulation: Monitor (SR-MN)	Having selected a link with an anticipated result, the reader monitors the choice that has been made
Self-regulation: Evaluate (SR-ER)	Actively evaluates the relevance of a particular reading choice while considering: Does this choice bring me closer or further away from my goal? Is this a likely and appropriate place for the information I need? Should I move to a deeper level, select a related topic, revert back to an earlier location, or start all over again?
<b>Actions</b>	
Physical reading action: Keyword (PRA-K)	Employs physical reading actions using a mouse or keyboard to navigate Internet text - types in keyword or phrase; types in website address
Physical reading action: Click (PRA-C)	Employs physical reading actions using a mouse or keyboard to navigate Internet text - clicks search button; clicks back button; clicks hyperlink
Physical reading action: Mousing (PRA-M)	Employs physical reading actions using a mouse or keyboard to navigate Internet text - moves mouse over text, across the screen, or under text
Physical reading action: Scroll (PRA-SI)	Employs physical reading actions using a mouse or keyboard to navigate Internet text - scrolls up, down, or across the page
Answer	States the answer to a given question
Writing	Writes notes or answers

**Figure 1: ORC Coding Scheme.**

Analysis of the coded transcripts (see Figure 2) revealed that the practices used by the participants for school and games websites are strikingly similar. An example of the practices demonstrated in the think-alouds would be a turn of talk like that of Wes, who said, "There is a thing at the top that uh...WoWWiki usually had sound clips and it's pretty, it's something like this. [clicks on a link and plays the sound file]." This demonstrates Wes's familiarity with WoWWiki as an informational website, which demonstrates his prior knowledge of informational websites. Similar examples can be found in the school examples.



**Figure 2: Graph of Online Reading Comprehension code occurrences for data set.**

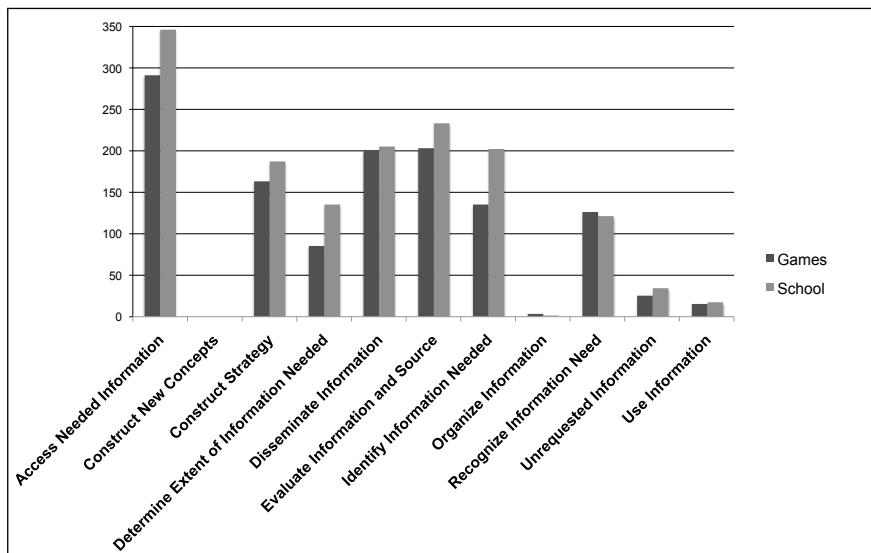
### Information Literacy

An a priori coding scheme for information literacy (Martin, in progress), expanded the five-step process of information literacy (AASL, 1998; ACRL, 2000), was applied to the data (see Figure 3). More variability was added to original five factors in order to look at the minutia of information seeking, such as breaking information seeking into two subcategories of recognizing information need and determining the extent of information need.

Information Literacy Coding Scheme	
Code	Definition
Recognize Information Need	To recognize needed information for a particular problem
Identify Information Needed	To identify information and resources that are necessary to fulfill the information need
Construct Strategy	To construct a strategy in order to locate and access needed information to fulfill the information need
Determine Extent of Information Need	To determine the extent of information needed to fulfill the information need
Disseminate Information	To disseminate information to others who have an information need or as a way of sharing results of the information literacy process
Organize Information	To organize retrieved resources and information for later use
Evaluate Information and Source	To evaluate information both for its applicability to fulfill the information need and the reliability of the source itself
Access Needed Information	To access needed information
Construct New Concepts	To apply prior and new information to construct new concepts or understanding
Use Information	To use information to fulfill the information need

**Figure 3: Information Literacy coding scheme.**

Preliminary analysis of the coded transcripts reinforced our findings that the information seeking practices within both game and school based texts are similar (see Figure 4). Further analysis can examine the correlations between codes and the participants' success in the activity.



**Figure 4: Graph of Information Literacy code occurrences.**

## Conclusions & Discussion

This study offers a look at the comparison between how people find different types of information from online resources and the types of online reading comprehension skills and information literacy practices that they employ, both for a more traditional informational, school-like topic such as tigers, and a more contemporary, games-related informational topic like murlocs in the *WoW* universe. One explanation for the similar approaches between school and leisure contexts could be that the tasks we have given them were essentially imposed queries. An imposed query is a question given to someone else to transact or resolve (Gross, 1995; 1999), as opposed to a self-generated query in which the information seeker has recognized an information need and has created the question they are seeking an answer for themselves. A major issue with imposed queries is that the person asking does not have context for the question; even if the context is explained to the person, it is not the same as having developed the need and then generating the question autonomously. Therefore, imposed information seeking is externally motivated and the questions are appointed or assigned (Gross, 1998). Self-generated information seeking is spawned by interest, the recognition of a need for information, and then the development of a question to fulfill the information need.

The imposed query prevented us from allowing the participants to make determinations about whether a site was credible and a sensible choice for the assigned questions. Instead, the text was selected for them, much like textbooks are selected by school boards and states rather than the students themselves. The constraints that this activity put on the natural information literacy processes of the participants was made apparent through their critique and push back on the rules that were designated for them. For example, one participant when asked to find answers to the questions on the worksheet told the interviewer, "That's what Google's for. Not this website." Another said, "I'm tempted to almost just search on wowwiki 'oracles.' Can I do that? (clicks back space and then scrolls down) Or is that not allowed?" this was in regards to a question that many participants had trouble finding, partly due to the wording of the question. A third said, "Am I allowed to just go on Google and search for a sample of Murloc?" These three examples illustrate how the activity affects the participants' natural online reading comprehension patterns, namely the approach they would use if they were looking for information on their own.

The critique given by the participants underlines how imposed query affects the online reading comprehension habits of an individual. Limiting the resources that are available to a person solving pre-structured problems changes the way they approach the problem, limiting their problem-solving abilities and online reading comprehension practices, just as seen in the imposed query research mentioned previously (Gross, 1995, 1998, 1999). Steinkuehler (2011) observed a similar phenomena in a study where she asked her participants to read texts that were at their grade level. In the first run of the study, participants performed nearly identically on a reading task with both a games and school-based text. In the second run of the study, participants selected their own game text, resulting

in marked improvement over their “school designated” reading level. The study demonstrates that students are able to read at a much higher reading level when choice and interest come in to play.

With the issue of imposed query creating similar results with the game and school activities and eliciting similar strategies in the coding schemes, we find that continuing analysis is needed. The analysis for this data set will continue using a finer grained analysis. This will look qualitatively at exactly what each participant did when they were successful in finding an answer and when they were unsuccessful in finding an answer. We will also look at the differences in practice that both the online reading comprehension and the information literacy schemes illustrate to create a comprehensive picture of seeking information in an imposed query context.

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# How Do Badges Make You Feel: Interest and Motivation in RITs Just Press Play Project

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**Abstract:** This paper discusses the Just Press Play game at Rochester Institute of Technology. This game is currently available to play for people in the Interactive Games and Media program, for students from freshman through graduate students. Including players that are in multiple stages of education creates a wider range of experiences that the community of players can draw on. The paper explores the ways in which the game creates interest and motivation exploring qualitative data. Then the qualitative analysis will be considered in the creation of qualitative open-ended survey questions. The survey questions are used as a form of assessment for the entire game. The interest and motivation of players was an original design concern and assessing whether players feel self-motivated and autonomous is important to success of the game and the development of the game further.

## Introduction

Just Press Play (JPP) is an achievement system created at Rochester Institute of Technology (RIT) to help undergraduate students establish stronger ties in the community and more engagement with their program of study. This game is currently available to play for students in the Interactive Games and Media (IGM) program, which includes undergraduate programs and graduate programs in Game Design & Development (GDD) and an undergraduate program in New Media. By including players from multiple stages of education, a wider range of experiences are created for the community of players.

A major consideration in the design of the game was that of the impact of an achievement system on player motivation. Research suggests that intrinsic motivation can be negatively affected when extrinsic rewards, such as gold stars (or achievements), are offered to students (Ryan, Rigby, & Przybylski, 2006), but that ensuring that students retain a sense of autonomy reduced or eliminated those negative impacts (Ryan & Deci, 2000a & 2000b). As a result, in the design of JPP every achievement was tested before implementation, to determine what sense of pride or accomplishment a player would take away from completion of the achievement.

In order to tailor the experience of Just Press Play to the specific educational environment, and to create achievements that offered students the most potential of gaining a sense of pride and accomplishment in their specific course of study, designers drew upon the history of RIT. They discovered that the university was originally formed by a merger of two very different institutions: the Rochester Athenaeum, and the Mechanics Institute. The Rochester Athenaeum focused on culture, philosophy, and the arts; in contrast, the Mechanics institute focused on industrial processes and the wonders of technology. The cultural conflicts that resulted from the merger of those two disparate institutions can still be seen at the university today, including in tension between the “design” and “development” aspects of IGM’s degree programs.

The Just Press Play game was developed from within IGM, with the intention of having IGM students as the pilot population for the game. It was designed to address the tension between arts and mechanics, as well as that between work done individually and work done collaboratively. Game activities were divided based on two axes—one is “exploration” vs. “mastery,” the other “individual activity” vs. “shared activity.” Achievements fall into different quadrants based on those axes, such as Individual Mastery or Shared Exploratory, and in different levels of difficulty starting with Initiate and moving out to Master.

This paper examines qualitative data concerning the Just Press Play game. It will examine data that explores the game from multiple perspectives and then consider qualitative interview questions that will explore the interest and motivation of players within the game.

## **Data Collection and Methods**

Qualitative data for this research will come from a variety of sources, including public forum discussions, posts from the website Reddit, public Facebook groups, comments from the Just Press Play game website, and semi-structured interviews with students participating in Just Press Play and faculty at RIT in IGM. The data presented here has been anonymized and pseudonyms have been applied.

This paper consists of an analysis of Reddit forum post which discusses the Just Press Play game as well as a discussion of interview questions that will be used to elicit the motivation of players participating in the Just Press Play game, as well as the social impacts the game has on players. The interviews will be conducted with players who are not playing Just Press Play currently, who are playing Just Press Play but are only marginally interested, who are playing Just Press Play but are neutral toward the game, and who are playing Just Press Play and are very interested and involved in the game. Additional interviews were conducted with faculty who are part of the IGM program and who have varying degrees of interest in participating with the game.

## **Analysis**

The first data point is an exchange made on the RIT forum on the Reddit website. It consists of an exchange of eight turns of talk with seven people contributing to the conversation. The conversation (Table 1) begins with a broad probing question that is intended to elicit responses from other IGM students. Along with the question of whether or not “anyone” had looked at the achievements, Contributor 1 makes a series of statements concerning the available achievements noting their difficulty, the amount of information available, when they are available, and how they are presented. Through this description because most of the information is presented in a negative light like “aren’t that hard” and “kinda cryptic” it seems as if Contributor 1 is not that impressed with the achievement system. Yet the last sentence of Contributor 1’s first turn of talk reveals the speakers true feelings for the Just Press Play and the available achievements “Go look for yourself!” they also include “(and if you’re IGM, go get your PlayPass keyfob and start playing)”. The exclamation point at the end of the imperative sentence, along with the second imperative clause inside the parentheses encouraging people to play Just Press Play if they are in the appropriate department, IGM, emphasize the excitement of Contributor 1.

Contributor 2 and 3 ask qualifying questions wanting to know where the achievements are listed and what Just Press Play is. Contributor 4 gives a simplistic break down of what just Press Play is and how it functions, although noting that they are not able to play because they are not in IGM. Contributor 1 agrees with the description, and shares that she/he believes that the game may be expanded if the beta goes well. Contributor 5 expands this saying that it will be expanded beyond RIT. Contributor 6 disagrees with the excitement that Contributor 1, making her/his sentiments known through the use of sarcasm. “Awesome...because we should totally be treating education as a game...that’s sure to gain A LOT of respect in the academic community .-.“ The ellipses are used to emulate pauses in speech. The phrases “we should totally” and “that’s sure to gain” are supposed to denote skepticism, just as the skeptical emoticon. Contributor 7 describes the activity she/he went through in order to accomplish an achievement. Contributor 7 expresses their zeal for the activity and regret that most of the achievements are not available until future points in time. Over all this exchange is positive concerning Just Press Play, being initiated by someone who has obvious enthusiasm for it. It also shows that the game is drawing interest from those who are unable to play because they are not in IGM, as well as skepticism from someone who has reservations about the role of video games.

Contributor 1	Anyone looked at the achievements for Just Press Play [JPP] yet? (Sorry if you're not IGM) So, I just took a quick look at some of the JPP achievements. Some of them aren't that hard, but their descriptions are kinda cryptic. Some of them aren't available for a few months (one isn't until the end of February). But, honestly...ohdeargod, so many bad puns. Go look for yourself (and if you're IGM, go get your PlayPass keyfob and start playing)!
Contributor 2	Where can I find these?
Contributor 3	What is Just Press Play?
Contributor 4	They're testing an achievement system for IGM majors. They have small RFID tags that they carry around, which activate achievement tracking. I don't know all the details (not being IGM myself), but you can read more here. <a href="http://play.rit.edu">http://play.rit.edu</a>
Contributor 1	Actually, you pretty much covered everything. If this beta goes well, the plan is to expand the system to all of RIT...I believe.
Contributor 5	And then other campuses, then K-12, etc etc.
Contributor 6	awesome...because we should totally be treating education as a game...that's sure to be gain A LOT of respect in the academic community --
Contributor 7	Just swarmed Jay's with 20 people for two achievements. Totally worth it. Too bad most of 'em don't work until later.

**Table 1: An exchange on Reddit (October 17, 2011)**

From the above several opinions about the game are expressed, from excitement and interest expressed both by those who could and could not play the game. Also, skepticism about equating games and education is expressed. However, this is an ill-informed opinion as a plethora of research has been conducted in supporting both the educational use of games and education occurring within commercial games (for examples of this literature see Barab, Arica, & Jackson, 2005; Barab et al., 2005; Chen, 2009; Gee, 2003; Gee & Hayes, 2010; Ketelhut et al., 2007; Martin & Steinkuehler, 2010; Squire, 2011; Steinkuehler, 2007; Steinkuehler, 2008).

## Discussion and Continuing Research

As noted in the introduction, a major design concern for creation of Just Press Play was that of creating a game that focuses on intrinsic motivation and supports player autonomy. Vansteenkiste and Deci (2003) found that even those who play and lose a game, if given autonomy and competitively contingent rewards, still remained motivated to play. Intrinsic goal framing produces a different quality of motivation than extrinsic goal framing which has a high cost to enjoyment and valuation of persistence (Vansteenkiste, Lens, & Deci, 2006). Vansteenkiste et al. (2004) found that offering intrinsic goals and autonomy increased learning-related outcomes.

The following questions will be asked of players and faculty concerning their interest in Just Press Play, games, and the social aspect of games.

1. Why did you participate in the Just Press Play game?
2. How do you feel about the game?
3. What do you think are the benefits of participation?
4. Are there any changes you would like to see made to the game?
5. How many achievements have you earned through Just Press Play?
6. What achievements were your most favorite?
7. What achievements were you least favorite?
8. How often do you visit the Just Press Play website?

9. What program are you part of at RIT?
10. Why did you choose this program?
11. Do you think the game brings any added benefits to the program?
12. What other games do you play? Titles? Genre?
13. Do you participate in any game communities (such as forums, wikis, websites, etc.)? If so which ones?
  - i. If you do participate in online communities for games, what does your participation look like?
  - ii. Why do you participate?
14. For you, are the social aspects of games important? Why or why not?
15. Is there anything else you would like to share concerning your participation in the game or the your program at RIT?

These questions are meant to elicit detailed information about both the activities and the motivations of the participants in Just Press Play. The information concerning interest in other games, as well as the interviewee's participation in the constellation of information around the game—that is to say the information and social resources around a game—are included to help determine the type of gamer and the what types of player identities that each player or faculty member displays (Martin, 2011). This will help build a more complete picture of motivation and player interest. Building on the evidence of underlying interest in the game, as illustrated in the example from Reddit, we intend to explore the motivation of players in reference to Just Press Play to help create a more enjoyable and engaging experience, and to help refine one function of the game which is to create a sense of community and connectedness amongst player for each other and to the program.

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# A User-Centered Theoretical Framework for Meaningful Gamification

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**Abstract:** Gamification is the "use of game design elements in non-game contexts" (Deterding et al, 2011, p.1). A frequently used model for gamification is to equate an activity in the non-game context with points and have external rewards for reaching specified point thresholds. One significant problem with this model of gamification is that it can reduce the internal motivation that the user has for the activity, as it replaces internal motivation with external motivation. If, however, the game design elements can be made meaningful to the user through information, then internal motivation can be improved as there is less need to emphasize external rewards. This paper introduces the concept of meaningful gamification through a user-centered exploration of theories behind organismic integration theory, situational relevance, situated motivational affordance, universal design for learning, and player-generated content.

## A Brief Introduction to Gamification

One definition of gamification is "the use of game design elements in non-game contexts" (Deterding et al, 2011, p.1). A common implementation of gamification is to take the scoring elements of video games, such as points, levels, and achievements, and apply them to a work or educational context. While the term is relatively new, the concept has been around for some time through loyalty systems like frequent flyer miles, green stamps, and library summer reading programs. These gamification programs can increase the use of a service and change behavior, as users work toward meeting these goals to reach external rewards (Zichermann & Cunningham, 2011, p. 27).

Gamification has met with significant criticism by those who study games. One problem is with the name. By putting the term "game" first, it implies that the entire activity will become an engaging experience, when, in reality, gamification typically uses only the least interesting part of a game—the scoring system. The term "pointsification" has been suggested as a label for gamification systems that add nothing more than a scoring system to a non-game activity (Robertson, 2010). One definition of games is "a form of play with goals and structure" (Maroney, 2001); the points-based gamification focuses on the goals and leaves the play behind. Ian Bogost suggests the term be changed to "exploitationware," as that is a better description of what is really going on (2011). The underlying message of these criticisms of gamification is that there are more effective ways than a scoring system to engage users.

Another concern is that organizations getting involved with gamification are not aware of the potential long-term negative impact of gamification. Underlying the concept of gamification is motivation. People can be driven to do something because of internal or external motivation. A meta-analysis by Deci, Koestner, and Ryan of 128 studies that examined motivation in educational settings found that almost all forms of rewards (except for non-controlling verbal rewards) reduced internal motivation (2001). The implication of this is that once gamification is used to provide external motivation, the user's internal motivation decreases. If the organization starts using gamification based upon external rewards and then decides to stop the rewards program, that organization will be worse off than when it started as users will be less likely to return to the behavior without the external reward (Deci, Koestner & Ryan, 2001). In the book *Gamification by Design*, the authors claim that this belief in internal motivation over extrinsic rewards is unfounded, and gamification can be used for organizations to control the behavior of users by replacing those internal motivations with extrinsic rewards. They do admit, though, "once you start giving someone a reward, you have to keep her in that reward loop forever" (Zichermann & Cunningham, 2011, p. 27).

Further exploration of the meta-analysis of motivational literature in education found that if the task was already uninteresting, reward systems did not reduce internal motivation, as there was little internal motivation to start with. The authors concluded, "the issue is how to facilitate people's understanding the importance of the activity to themselves and thus internalizing its regulation so they will be self-motivated to perform it" (2001, p. 15). The goal of this paper is to explore theories useful in

user-centered gamification that is meaningful to the user and therefore does not depend upon external rewards.

### **Organismic Integration Theory**

Organismic Integration Theory (OIT) is a sub-theory of self-determination theory out of the field of Education created by Desi and Ryan (2004). Self-determination theory is focused on what drives an individual to make choices without external influence. OIT explores how different types of external motivations can be integrated with the underlying activity into someone's own sense of self. Rather than state that motivations are either internalized or not, this theory presents a continuum based upon how much external control is integrated along with the desire to perform the activity. If there is heavy external control provided with a reward, then aspects of that external control will be internalized as well, while if there is less external control that goes along with the adaptation of an activity, then the activity will be more self-regulated.

External rewards unrelated to the activity are the least likely to be integrated, as the perception is that someone else is controlling the individual's behavior. Rewards based upon gaining or losing status that tap into the ego create an introjected regulation of behavior, and while this can be intrinsically accepted, the controlling aspect of these rewards causes the loss of internal motivation. Allowing users to self-identify with goals or groups that are meaningful is much more likely to produce autonomous, internalized behaviors, as the user is able to connect these goals to other values he or she already holds. A user who has fully integrated the activity along with his or her personal goals and needs is more likely to see the activity as positive than if there is external control integrated with the activity (Deci & Ryan, 2004).

OIT speaks to the importance of creating a gamification system that is meaningful to the user, assuming that the goal of the system is to create long-term systemic change where the users feel positive about engaging in the non-game activity. On the other side, if too many external controls are integrated with the activity, the user can have negative feelings about engaging in the activity. To avoid negative feelings, the game-based elements of the activity need to be meaningful and rewarding without the need for external rewards. In order for these activities to be meaningful to a specific user, however, they have to be relevant to that user.

### **Situational Relevance and Situated Motivational Affordance**

One of the key research areas in Library and Information Science has been about the concept of relevance as related to information retrieval. A user has an information need, and a relevant document is one that resolves some of that information need. The concept of relevance is important in determining the effectiveness of search tools and algorithms. Many research projects that have compared search tools looked at the same query posed to different systems, and then used judges to determine what was a "relevant" response to that query. This approach has been heavily critiqued, as there are many variables that affect if a user finds something relevant at that moment in his or her searching process. Schamber reviewed decades of research to find generalizable criteria that could be used to determine what is truly relevant to a query and came to the conclusion that the only way to know if something is relevant is to ask the user (1994). Two users with the same search query will have different information backgrounds, so that a document that is relevant for one user may not be relevant to another user.

This concept of "situational relevance" is important when thinking about gamification. When someone else creates goals for a user, it is akin to an external judge deciding what is relevant to a query. Without involving the user, there is no way to know what goals are relevant to a user's background, interest, or needs. In a points-based gamification system, the goal of scoring points is less likely to be relevant to a user if the activity that the points measure is not relevant to that user. For example, in a hybrid automobile, the gamification systems revolve around conservation and the point system can reflect how much energy is being saved. If the concept of saving energy is relevant to a user, then a point system based upon that concept will also be relevant to that user. If the user is not internally concerned with saving energy, then a gamification system based upon saving energy will not be relevant to that user. There may be other elements of the driving experience that are of interest to a user, so if each user can select what aspect of the driving experience is measured, more users will find the system to be relevant. By involving the user in the creation or customization of the gamification system, the user can select or create meaningful game elements and goals that fall in line with their own interests.

A related theory out of Human-Computer Interaction that has been applied to gamification is “situated motivational affordance” (Deterding, 2011b). This model was designed to help gamification designers consider the context of each of the elements of a gamification system. This theory is based upon the underlying concept of “motivational affordance” is that a user is motivated by an aspect of a system only when there is a match between that aspect and the background of the user, which is very similar to the concept of situated relevance. Deterding moves this underlying concept forward by introducing the importance of the organizational context into which the activity is situated in the gamification system. If an element of gamification is tied to a financial award in a company, the perception of the gamification as a controlling activity by a user is greater than if the same element leads to nothing more than a badge or listing on a leaderboard (2011b). Putting these two theories together means that for meaningful gamification, it is important to take into consideration the background that the user brings to the activity and the organizational context into which the specific activity is placed. A significant challenge in creating this type of a broad system is developing a strategy to encompass a wide variety of user backgrounds, desires, and skillsets.

## **Universal Design for Learning**

The theory of Universal Design for Learning (UDL) from the field of Education is a guide for instructional designers to help them create course content that is appropriate for a diverse group of learners. The idea behind UDL is that courses should be designed so that students can demonstrate learning in a variety of ways. For example, instead of having all students take exams or give presentations, students should be able to select the way in which they demonstrate how they have met learning outcomes. The result is a course that is meaningful for a wider variety of learners (Rose & Meyer, 2002).

There are three strategies to creating content for a wide variety of learners. The first strategy is to think about different ways to present the content of learning—the "what". The second strategy is to think about providing different activities for the learner to explore and demonstrate mastery of content—the "how". The third strategy is to give learners different paths to internalize content and become engaged and motivated—the "why" (Rose & Meyer, 2002).

The underlying concept of UDL applies to the creation of meaningful gamification. If users are allowed to demonstrate their mastery of an activity in only one way, then the system will not be meaningful to users who can perform activity but demonstrate it in a different way than what is measured. The design implication of this is that gamification systems need to either allow different ways for users to achieve goals so that users can be involved in the ways most meaningful to them or to allow users to set their own goals and achievements.

The different UDL strategies can be used to think through the different aspects of a gamification project to add additional ways to making the gamification meaningful. The "what" in gamification are the aspects of the underlying non-game activity that are being transformed with game design elements. Many gamification projects focus on only a single activity; if a user does not perform that activity well, then he/she will not be able to participate in the rest of the gamification system. By thinking of the desired outcomes of the non-game activity, designers can consider other ways that users can reach the same outcome. The "how" in gamification refers to how the game elements are manifested. This can be the points and achievements system or, preferably, the more meaningful elements that are embedded within the underlying non-game activity.

For some users, a point system attached to public status is important enough to them to perform a dull task, but for others a leaderboard is meaningless and the task itself needs to be transformed through gameful activities to provide that connection. Providing multiple ways to achieve within the gamification system can allow users to select those methods most meaningful to them. The "why" is an exploration of different ways to help the users connect the gamification process to their own background. A scoring system that has no deeper connection to the underlying activity than a quantification provides no way for a user to make a meaningful connection to the activity. By making each application of a game element be meaningful in a different way, the chances a user will find some way of connecting to the gamification more deeply will increase. Ensuring that there are a variety of ways for the "what", the "how", and the "why" will allow more users to find meaningful connections to the gamification. Developing this wide variety of aspects to a gamification project can

be a challenge, but opening up the design of the gamification to users of the system can help designers overcome that challenge.

## Player-Generated Content

One game design feature that has grown in popularity with the ease of online connectivity through games is player-generated content, which some in Game Studies are calling “Gaming 2.0” (Djaouti, et al, 2010). This concept has been at the center of tabletop roleplaying games for decades, and early text-based Multi-User Dungeons (MUDs) allowed players to generate content within the game that others could then interact with. Games such as *Half Life* have opened themselves up to modification, so that players can create new worlds for others to explore; some of these modifications, such as the *Counter-Strike* modification for *Half Life*, were as popular as the original game. *Second Life* was centered around player-generated content in a massively multiplayer virtual world, and as online networks behind console play have strengthened, games like *Little Big Planet* allow players to engage with what others have created. *World of Warcraft* allows players to create and share new aspects of the user interface to the game, and the company integrates the best ideas into new official releases of the game’s interface. What is common in these games is that the game designers created not only a game, but developed a system to allow others to create and modify the games. Allowing player-developed content extends the life of a game and allows the designers to see how creative users can be with the toolkits provided.

One of the ways to allow users to make gamification experiences that are more meaningful is to allow players to set their own goals. Deterding (2011a) puts it well in his notes to his Google Tech Talk on gamification: “One practical way to do this is to allow users to set and customize their own goals within the platform. The design challenge here is to support and guide the user in setting long- and short-term goals such that they become achievable and provide experiences of mastery on the way” (p. 37). An example of this is *Chore Wars*, where participants create quests for a household or other shared space to complete routine chores. McGonigal talks about numerous cases how *Chore Wars* improved engagement with household chores as a case in her book, *Reality is Broken* (2011).

The freedom that users have in setting their goals can be based upon the needs of the gamification system. In educational contexts where certain learning goals must be met, then constraints can be placed upon the user’s choices to guide him or her toward making choices that are both meaningful to the user and that meet the needs of the organization. By being transparent about the constraint process, the users can learn about why constraints are in place, become more informed about learning outcomes, and then see how the game elements are connected to the learning outcomes.

When applying the concepts behind player-generated content to meaningful gamification, the underlying idea is that the designers develop a system where users can create their own tools to track different aspects of the non-game activity, to create their own leveling systems and achievements, to develop their own game-based methods of engaging with the activity and to be able to share that content with other users. Systems where users can transform tasks by adding elements of play and then share their new methods allow creative users to think about how to make a task fun without an external reward. Users working toward the same set of goals can then form communities around those goals. These communities of learners can share experiences and increase their learning around the non-game activity, which OIT suggests is a method more likely to create truly internalized experiences.

## Bringing it Together through User-Centered Design

All of these theories have one thing in common: the user is at the center. The theory of user-centered design is ensuring that the user’s needs and goals are the primary consideration at every stage of the process (Norman, 1990). Each of the theories presented here provides different ways for a designer to consider the user. The concept of putting the user at the center of the gamification project is so critical that it is key in the definition of meaningful gamification:

*Meaningful gamification is the integration of user-centered game design elements into non-game contexts.*

The implications of focusing on user-centered design can help designers avoid meaningless, or even harmful, gamification. Using external rewards to control behavior creates a negative feeling in the user about the non-game context; therefore, the use of external rewards is not user-centered. Instead, user-centered game design elements have to be meaningful to the user and should result in positive

change in the user's mindset. During every decision in the gamification process, the user-centered designer must ask: "How does this benefit the user?"

Another critical component of user-centered design is that of information. In order for a user to understand what is happening, it is important that he or she has more than just a numeric score attached to an activity. Having only a numeric score does not allow the user the information to understand what is really going on and can make the user suspicious and questioning of the motives behind the score. The creation of that scoring system is based upon assumptions and biases of the organization creating the gamification system, and therefore, the user is more likely to perceive the gamification as externally controlling. By making systems more transparent with the goal of providing the user with information instead of providing the user with a score, the user can then create their own games and goals. Constraints on these goals can be provided, if needed, with appropriate justification so that the user has the information needed to make a decision.

The opposite of meaningful gamification would be meaningless gamification, and at the heart of meaningless gamification is organization-centered design. Gamification tactics that rely upon points and levels leading to external rewards that are not related to the underlying activity are not concerned about the long-term benefits of the gamification on the user; they are focused on increasing the organization's bottom line in the short term. These designers are first asking: "How does this benefit the organization?" instead of how the gamification benefits the user. Creating meaningful gamification that benefits the user and creates a positive impression of the non-game context will then have a long-term benefit for the organization. The benefits to the company result from the positive and meaningful benefits for the user.

Another threat to meaningful gamification is mechanism-centered design. A trap that game designers and companies can fall into is seeing a new or interesting game mechanism and deciding to build that into the gamification. Sometimes, this clever mechanism doesn't integrate well into the non-game setting; therefore, while a novel mechanism can draw users into the gamification, the lack of integration means that users won't fully engage with the underlying activity. Another risk is for an organization to bring in a "gamification consultant" who applies a standardized points-based approach to every setting. Bringing in a generic game activity that doesn't match the underlying non-game setting will create a hollow gamification experience. In both examples, the focus is not on what is best for user, but on what is the best, coolest, or easiest-to-implement game without consideration for the user's underlying needs and goals.

Meaningful gamification is more challenging to create than meaningless gamification, as designers can't rely upon a cookie-cutter approach of meaningless points leading to external rewards. Instead, the game elements need to come out of aspects of the underlying activity that are meaningful to the user. Instead of relying upon external rewards as the sole way to motivate, connections between the game elements and important aspects of the activity are presented to help the user make relevant connections between aspects of the non-game activity and his or her own goals and desires. Since users are different, a design challenge is either offering a wide variety of ways to interact with the game or creating a flexible system that will allow user customization so it will be relevant. Introducing the ability to share these customizations will allow users to find others that are similar, which can be a meaningful result of the gamification process.

## **Examples of Meaningful Gamification**

Rather than using a point system, meaningful gamification encourages a deeper integration of game mechanisms into non-game contexts. Meaningful gamification techniques focus on the consideration of aspects of the underlying activity to understand where an integration of game elements makes sense. Even more intriguing is to go beyond games into the integration of pure play elements. A game without scoring can be called play; therefore, removing the scoring elements from a gamification context encourages a focus on the integration of play. An excellent example of this is a subway in Sweden where they added a piano keyboard to the stairs going into the subway, and many more people took the stairs instead of the escalator (Volkswagen, 2009). Perhaps this concept is important enough for its own term: "playification" is the use of play elements in non-play contexts.

A class of examples of meaningful gamification is most Alternate Reality Games (ARGs). In these games, game elements are used to tell a story that is based upon a non-game setting. Many of these games allow a variety of ways to interact with the ARG and emphasize an engaging story and

interesting activities instead of relying upon a point system and leaderboards. While these score-based elements may exist in the ARG, a well-designed ARG doesn't need these tools to create an engaging and meaningful experience. Many ARGs have community-based aspects so that participants can find meaning through group engagement as well as their personal interest. Developing an ARG is a time-consuming process that requires designers to understand the non-game setting well enough to integrate gaming elements in a meaningful way. McGonigal argues that good ARGs present obstacles within a story with a wide scope, and that players feel satisfied and positive about their own abilities by overcoming them (2011).

Another example of meaningful gamification is the display of the Toyota Prius. This game-like display shows the driver if power is coming from the fuel or battery, and when power is being directed back into the battery. The driver can get information about how their driving is affecting the car. This information enables the driver to create their own games and goals. If the car simply presented the driver with a "Green Score" without this information, the driving experience would be much less meaningful. Taking this concept further, a physical therapy visualization tool that allows the patient to see how the body is changing as he or she does each repetition can allow each patient to set a different goal that is meaningful. The therapist can help the patient set goals through constraints, and by exploring those constraints, the patient can then understand how the physical therapy connects to the exercise goals. By giving the patient information and control over goals, the patient is much more likely to find the internal meaningful connections to be able to continue the therapy away from the therapist.

## Conclusion

In conclusion, meaningful gamification puts the needs and goals of the users over the needs of the organization. If users have a positive and meaningful game-based experience that is well connected to the underlying non-game setting, then the organization will benefit in the long term. Meaningful gamification focuses on introducing elements of play instead of elements of scoring. The same activities will not be meaningful to all users, so designers need to provide a variety of game-based activities to appeal to different users or a customizable gamification system where users can create their own activities. The dependence upon external rewards for motivation should be replaced by connections between the non-game activity and needs or goals in the user's life based upon information, which will allow users to have a positive internalized experience. The resulting user-centered meaningful gamification will result in longer-term and deeper engagement between participants, non-game activities, and supporting organizations.

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# Epistemological Beliefs in Games vs. School: A Mixed-Methods Approach

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**Abstract:** This paper outlines a study examining whether adolescent videogame players hold different epistemological beliefs in the game space compared to their school realm. We presented a group of adolescent *World of Warcraft* players, a massively multiplayer online (MMO) game in which the participants play together to accomplish shared goals, with two isometric epistemological surveys (one regarding the game and the other regarding school) to determine whether there is a difference in their beliefs about the nature of knowledge and learning in game play compared to school. In triangulating the quantitative survey results with qualitative gameplay chat data, our results indicate that adolescent players are significantly more likely to believe that hard work is rewarded with learning and success in the context of the game, whereas in a school-based context players tended to believe the opposite: that one can't learn how to learn, and success is unrelated to hard work.

## Introduction and Theoretical Framework

Leaders in education throughout the post-industrial era have questioned beliefs about the nature of knowledge. These epistemological explorations go back even as far as Dewey, who challenged the idea of science knowledge as simply a collection of fact (1910). Rather, he repeatedly cautioned against the teaching of science as just content rather than process. "The future of our civilization," he maintained, "depends upon the widening spread and deepening hold of the scientific habits of mind" (1910, p. 127). In the last few decades, Chinn and Malhotra and the American Association for the Advancement of Science have further reinforced the skill-based nature of science, delineating much scientific content as thinking processes and strategies for obtaining knowledge (Chinn and Malhotra, 2002; AAAS, 1993). Using this epistemological framework, recent research has shown evidence of scientific thinking in virtual worlds (Steinkuehler, 2008), specifically suggesting "social construction of knowledge", a scientific habit of mind based on the assertion that scientists construct knowledge in collaborative groups (AAAS.D.12.6 & 1.A.12.2; Chinn and Malhotra 2002).

Thus, Dewey's century old prophecy may be coming true—that in the new frontier of technologically-driven learning, it is the scientific thinking processes and habits of mind that persevere. But how else does his discussion of epistemological beliefs apply? Beyond the characteristics of the subject matter, epistemological beliefs of the learners themselves may well be fueling the very habits of mind that make for mastery of science, or any semiotic domain (Gee, 2003). For example, the scientific habits of mind found prevalent in online *World of Warcraft* (*WoW*) forums (Steinkuehler, 2008), demonstrates the kind of collective intelligence that is driven by the willing participation/contribution of its community members. In such a participant-driven learning community, the members' attitudes about their own potential to learn and share their knowledge (more formally known as epistemological beliefs) very likely contribute to their engagement in their community of practice (Lave & Wenger, 1991). Put simply, the members' epistemological beliefs can greatly affect their participation in (and therefore the success of) their own learning endeavors. Bandura discusses self-efficacy (1986) in similar terms, asserting that "what people think, believe, and feel affects how they behave," and that "the natural and extrinsic effects of their actions, in turn, partly determine their thought patterns and affective reactions" (p. 25). In previous studies, the impact of epistemological beliefs on academic performance has been well documented; Paulson & Feldman (1999) found that students who have a strong belief that the ability to learn is fixed at birth are less likely to engage in self-regulated learning strategies. They also found that students who believe strongly that learning happens either quickly or not-at-all are less likely to engage in elaborate study strategies. Schoenfeld (1983) found that students who believe learning takes place very quickly (and don't believe one can learn much over a longer time) are less likely to take on computation tasks in math that will take longer than a few minutes. In parallel, Steinkuehler (2008) found that in the body of *WoW* online forum data (in which 85% evidenced the desirable scientific habit of mind "social construction of knowledge"), 65% of the total forum posts demonstrated the positive epistemological belief that "knowledge is an open-ended process of evaluation and argument" (an epistemological statement adapted from Diane Kuhn (1992)). Therefore, the development of scientific habits of mind and cross-curricular problem-solving

approaches seem to have strong epistemological roots. Inspired by these findings—and intrigued by the seeming differences in attitudes about learning between traditional school environments and informal virtual worlds like WoW—our lab undertook a study specifically examining epistemological beliefs in school vs. games.

## An Epistemological History

In the last 50 years, epistemology has grown from an emergent topic to a broadly researched field, in which various domains and demographics have been studied, and qualitative and quantitative instruments been developed. For our study, the research team chose a well-established quantitative assessment called the Epistemology Questionnaire (EQ), which was developed by Schommer (1998).

Schommer based much of her work on one of the first epistemological researchers, William Perry. In the 1950's, he initiated an official exploration of "epistemology" (1968). Surveying and interviewing Harvard undergraduates, Perry found that many first-year students believed that knowledge is simple, certain, and handed down by omniscient authority. By the end of their four years at Harvard, Perry found his subjects had undergone a series of evolutions in their epistemological beliefs—specifically, that many then believed knowledge is complex, tentative, and derived through reason and empirical evidence.

Following Perry, the work of Dweck and Leggett (1988) is especially relevant to this study, with their findings that "helpless individuals appear to focus on their ability and its adequacy (or inadequacy), mastery-oriented ones appear to focus on mastery through strategy and effort; whereas helpless individuals appear to view challenging problems as a threat to their self-esteem, mastery-oriented ones appear to view them as opportunities for learning something new" (p. 259). The "helpless" individuals were characterized as such because of their behavior in the face of their belief that ability to learn is fixed. It was this distinction of a "fixed ability" belief that served as an important precursor to Schommer's 1990 article—the work on which this study's surveys and assessment of survey data were based. Also influential in the 1980's was the work of Schoenfeld (1985), uncovering epistemological beliefs about the speed of learning, as well as the work of Baxter Magolda & Porterfield (1985) in developing epistemological assessments.

In "Effects of beliefs about the nature of knowledge on comprehension," published in 1990, Marlene Schommer offers the view that epistemological beliefs be conceived as multidimensional. She argues for four main categories of epistemological beliefs: "(a) stability of knowledge, ranging from never changing to always evolving; (b) structure of knowledge, ranging from isolated bits to highly interrelated concepts; (c) speed of learning, ranging from quick or not-at-all to gradual; and (d) ability to learn, ranging from fixed at birth to life-long improvement" (Schommer et al., 2003, p. 350). In this 1990 article, Schommer uses these four categories to develop a measurement central to this study: Schommer's Epistemology Questionnaire. The survey is structured around the four factors of stability of knowledge, structure of knowledge, speed of learning, and ability to learn. The purpose of the survey is to produce a quantitative measurement of the given person's epistemological beliefs in each category. A large reason she distinguishes these categories is because she believes each one to be more or less independent from one another in an individual. Schommer's 1993 publication continued her research with secondary school students, for whom the survey was originally intended. It was later refined for different ages of subjects, including an updated version (Schommer, 1998) based on her research on college age subjects (1997).

## Methods

This study was conducted as part of a larger, two-year line of inquiry exploring the impact of a game-based casual learning lab on adolescent boys' literacy and learning. Twenty-two lab participants took part in the study total. All participants were male and between the ages of 13 to 18. The goal of the afterschool program was to leverage the boys' existing interest in videogames to strengthen their interest in literacy as a tool for problem solving, researching online information resources, and synthesizing in-game and out-of-game information. As part of this lab, participants and researchers played WoW together regularly online as fellow guild members (i.e. as part of an in-game group) and maintained a private online guild forum for out-of-game asynchronous discussions. In addition, the lab hosted Saturday monthly face-to-face meetings, which allowed for both group gaming and data collection, including participant observation, surveys, and studies. The study detailed here took place over a few such Saturday events.

There were two surveys given to the participants, both based directly off of Schommer's Epistemology Questionnaire (Schommer, 1998). Schommer's original survey is structured around four factors, which include stability of knowledge, structure of knowledge, speed of learning, and ability to learn. Each category is broken down into subsets; for example, the large category of "Speed of Learning" is broken down into subcategories "Learn the First Time," "Learning is Quick," and "Concentrated Effort is a Waste of Time." The survey is written with 63 items, asking the subject to rate their response to each item on a Likert scale from 1 to 5. A higher converted score on an item indicates a more "naïve" (limited or potentially harmful) belief about knowledge, whereas a lower final score on an item indicates a more "sophisticated" (constructive) belief about learning. In turn, each item fits into a subset of one of the larger categories.

4 FACTORS	12 SUBSETS	63 ITEMS (selected examples)*
Ability to Learn	Can't Learn How to Learn	- A course in study skills would probably be valuable.
	Success is Unrelated to Hard Work	- Genius is 10% ability and 90% hard work.
	Ability to Learn is Innate	+ Some people are born good learners, others are just stuck with limited ability.
Speed of Learning	Learn the First Time	+ Almost all the information you can learn from a textbook you will get during the first reading.
	Learning is Quick	- If a person can't understand something within a short amount of time, they should keep on trying.
	Concentrated Effort is a Waste of Time	+ If a person tries too hard to understand a problem, they will most likely end up being confused.
Structure of Knowledge	Seeks Single Answers	+ The best thing about science courses is that most problems have only one right answer.
	Avoid Integration	- I try my best to combine information across chapters or even across classes.
	Avoid Ambiguity	+ It's a waste of time to work on problems which have no possibility of coming out with a clear-cut and unambiguous answer.
Stability of Knowledge	Knowledge is Certain	+ Truth is unchanging.
	Depend on Authority	- When you first encounter a difficult concept in a textbook, it's best to work it out on your own.
	Don't Criticize Authority	+ People who challenge authority are over-confident.

The symbol “-” indicates phrasing in terms of a sophisticated epistemological view; “+” indicates phrasing in terms of a naïve view.

**Table 1: Structure of Original Schommer Epistemology Questionnaire (Schommer, 1990)**

The two surveys our research team gave the players were identical to Schommer's in structure, order, and items. To develop the games survey, we created an isomorphic survey item by item while changing the content of each item from school to games-related measures. We then checked validity by circulating the instrument among fifteen players who marked each item as good or bad and suggested edits. Once this member-checking phase was finished, we then grouped together the items based on the underlying factors they were intended to measure and checked to make sure that the item indeed still reflected the true spirit of the underlying construct. When that was confirmed, we put the items back in their original order.

Each survey had 63 items with identical structures mirroring the original. The surveys were given about 5 months apart. This was done purposely so that participants would have some gameplay experience as context by the time they took the games survey (prior school experience was a given, so no delay on the experiment timetable was necessary).

After gathering the group of boys, giving the spaced-out surveys, and recording eight months of chat data, the data collection phase was over. The next step involved quantitatively analyzing the epistemology surveys according to Schommer's guidelines and then finding any statistically significant differences between the participants' epistemological beliefs regarding school versus games. Then, using our quantitative results, we developed a series of qualitative codes and combed through the chat data in order to find excerpts related to our survey findings. Next was cleaning up the excerpts, removing lines of chat of research facilitators and players who had not taken the epistemology surveys. Lastly, the excerpt data was sorted, sequenced, and quantitatively grouped to show any significant patterns triangulating our quantitative survey data.

## Results

After processing the raw survey data into final scaled scores (according to Schommer's instructions (1998)), paired-sample t-tests revealed significant differences between the game and school contexts on two subsets: "Success is unrelated to hard work" and "Can't Learn How to Learn" (see table 1). We then identified two major coding categories: Naïve and Sophisticated epistemological beliefs. Using the statistically significant subsets above, we were then able to create a distinct coding scheme (Chi, 1997) for the qualitative data: *can't learn how to learn (N1)*, *success is unrelated to hard work (N2)*, *can learn how to learn (S1)*, *success is related to hard work (S2)*.

	(N) Naïve	(S) Sophisticated
<b>(1) learning is unable / able to be learned</b>	N1 0%	S1 27%
<b>(2) success unrelated / related to hard work</b>	N2 5%	S2 68%
<b>% breakdown</b>	5%	95%

**Table 2: Graphic Organizer of Qualitative Codes**

The complete data set consisted of 454 photos, 66 forum posts, over 100 hours of video, and 2,506 pages of in-game chat logs. The data was analyzed with 11 themes and 44 codes, two of those were "nature of knowledge" and "nature of learning". The specialized epistemology codes from Table 2 were then applied to this secondary, smaller data corpus. After this coding, a simple percentage breakdown of excerpts per code revealed clear patterns. Excerpts expressing a naïve attitude about the nature of learning accounted only for 5% of the total, while amount of epistemological talk expressing a sophisticated view of accounted for 95% of the relevant chat corpus.

## Discussion

Both the results from the players' surveys and the coded excerpts support the conclusion that learners tend to believe that success and learning are *achieved* abilities in games, and *fixed* abilities when it comes to school.

The differences between school vs. games context on "Can't Learn How to Learn" and "Success is Unrelated to Hard Work" subsets were statistically significant, with views significantly more "sophisticated" on the games survey than on the school survey. This signaled that the participants felt in WoW learning and success can be achieved through effort.

In terms of the qualitative data, sophisticated (rather than naïve) epistemological talk accounted for 95% of the relevant chat corpus. (Table 2) clearly supports patterns found within the survey data that players tend to believe in achieved learning and success in WoW. Corroborating this is the fact the naïve belief that one *can't learn how to learn* comprises 0% of all coded excerpts over 8 months of play. It is also interesting to note that the majority of coded excerpts (68%) pertained to *success is related to hard work*. One possible explanation is that success on an immediate goal in the naturalistic setting of gameplay may have been a highly concrete, relevant discussion topic.

In addition to the large proportion of “sophisticated” codes, the excerpts’ progression over time supports the idea that epistemological beliefs about achieved ability are perpetuated by the game. The only fixed ability codes in the participants’ excerpts appeared in early November (within the first two months of the study), suggesting that already sparse naïve epistemological beliefs may fade out as the gameplay progresses.

Individual excerpts from the players show promising evidence of their belief in achieved success and ability to learn in *WoW*. One player in particular got discouraged early on in the study—declaring in a glaring N2 (naïve) code, “idc [I don’t care] I’m never gonna get this guy up to [level] 70”. However, in the progression of the rest of the study, he had five different excerpts signaling his belief in achieved success (S2) and ability to learn (S1). “I got to lvl 80 so fast because someone said it was impossible,” he announced in December, just two months after he had made his previous defeatist prediction. Other players discovered they could achieve progress in the game through hard work. One participant said “idk [I don’t know] but when I focus I can level hella fast,” echoing the sentiment of a fellow player who said that “yay!” he’s “getting better” and that he really “like[d] learning new moves and stuff.” Another participant, inspired by the gameplay, began a discussion with direct commentary on the human ability to learn: “A younger mind has greater plasticity of course but that doesn’t mean that a greater/deeper context for information to placed into doesn’t give its own advantage” (a resounding code S1).

## Conclusions & Future Research

This epistemological study did support our original supposition that learners hold more constructive, sophisticated epistemological beliefs about games than they hold about school. In future research, a compelling direction would be to investigate specifically what about games triggers or sustains these sophisticated epistemological beliefs, and what triggers more pessimistic, naïve views in school. It would be interesting to attempt to separate the initial positive epistemological attitudes about games from the mechanisms that sustain them within the game. Finally, collecting a sampling of classroom chat data to parallel the *WoW* chat data, and coding it using qualitative codes, could yield relevant information. Ultimately, though, this study was fascinating because it helped to quantify something we intuitively suspected: that for players of *World of Warcraft*, the results of hard work and repeated attempts to learn are extremely rewarding. In other words, in that gaming context, learning was intrinsically rewarding and motivating—something educators strive to tap into every day in their own classrooms.

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# Game-Based Assessment: An Integrated Model for Capturing Evidence of Learning in Play

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**Abstract:** This paper presents a Game-Based Assessment model (GBA) designed to capture relevant information on play and testing whether it can constitute reliable evidence of learning. A central challenge for videogames research in education is to demonstrate evidence of player learning. Assessment designers need to attend to the ways in which game-play itself can provide a powerful new form of assessment. The GBA model has two layers: a *semantic template* that determines which click-stream data events could be indicators of learning; and *learning telemetry* that captures data for analysis. This study highlights how the GBA was implemented in a stem-cell science learning game, and shows how the GBA demonstrates a relationship between kinds of failure and learning in the game.

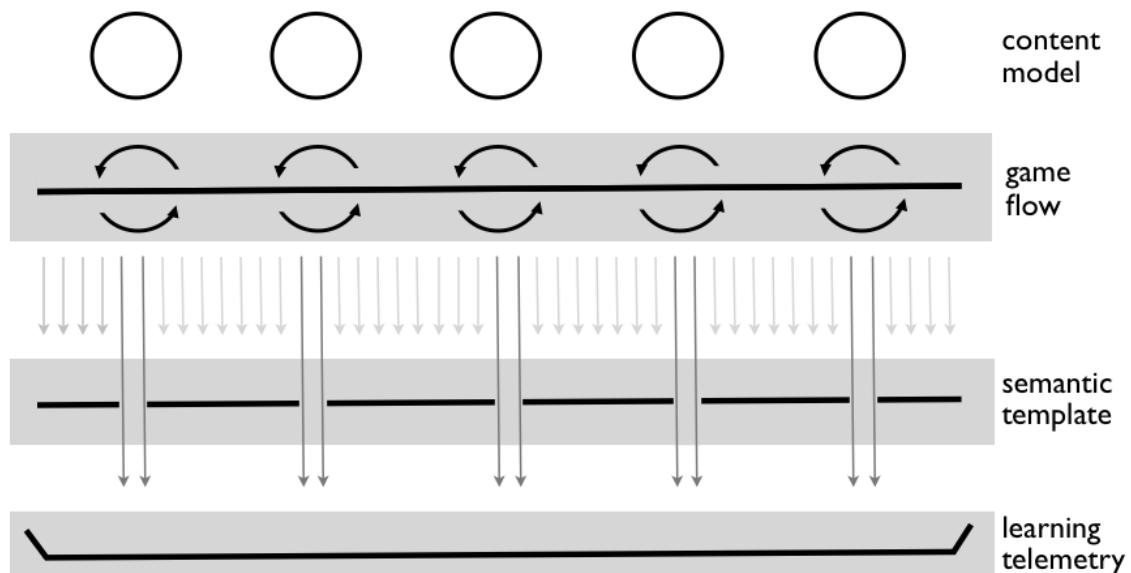
## Objectives and Theoretical Framework

A central challenge for videogames in education is to demonstrate evidence of player learning. A typical approach to assess learning in games is to measure the quality of player learning in terms of independent, pre-post instruments. This process can compare game-based learning against other kinds of interventions, but, in treating the game itself as a black box, we lose the unique characteristics of the games as a learning tool. James Gee has suggested that games themselves provide excellent models for designing the next generation of learning assessments. Well-designed games reward players for mastering content and strategies, scaffold player activities toward greater complexity, engage players in social interaction toward shared goals, and provide feedback (through gameplay) that allows players to monitor their own progress (Gee, 2005). Rather than ignore the motivating and information-rich features of games in capturing learning, assessment designers need to attend to the ways in which game-play itself can provide a powerful new form of assessment. This requires learning researchers to think of games as both intervention *and* assessment; and to develop methods for using the internal structures of games as paths for evidence generation to document learning.

This paper presents a Game-Based Assessment model (GBA) designed to capture data on player learning in the midst of game-play. The GBA model has been developed by the Games, Learning and Society (GLS) Research group as a process for capturing relevant information on play and testing whether it can constitute reliable evidence of learning. The GBA model draws on concepts and tools from evidence-centered design (e.g. Mislevy & Haertel, 2006), stealth assessment (Shute, 2011) and educational data mining (e.g. Baker & Yacef, 2009) to describe a strategy for building assessment tools into game design from the ground up in order to use game play itself as the barometer of player learning.

## GBA Model and Methods

The Game-Based Assessment model is grounded in the content model and game-flow design of the game development process, and emphasizes two key layers: the *semantic template* and *learning telemetry*. Below, we describe each feature of the model in context of *Progenitor X*, a GLS game about regenerative medicine.



**Figure 1: Game-Based Assessment Model**

The GBA model is designed to draw significant game-play moves from the game-context. The model has integrated into an overall 4-layer GLS game design strategy: the *content-model*; the *game flow* design; the *semantic template*; and the *learning telemetry* (Figure 1). The first two layers, the content model and the game flow design, constitute the game design process. The content model outlines the learning goals for the game. The game flow design builds player interaction opportunities around these learning goals to create a gaming experience. The final two layers, the semantic template and the learning telemetry, form the assessment process. The semantic template selects relevant data from the click-stream generated by game-play; the learning telemetry layer collects and organizes the resulting data-record into player-profiles. Here we provide a brief overview of how these layers, using the game *Progenitor X* as an example, comprise a generic blueprint for our approach to assessment-driven game design.

**Content Model.** The content model for a GLS game consists of several content chunks that string together a series of core concepts along a process that represents current thinking in a domain. Because the resulting medium for interaction is a game, rather than a simulation, the design team is concerned with creating motivating conditions of play as well as the representational accuracy of the content model. *Progenitor X* provides an example.

*Progenitor X* invites players to dissect, collect, cultivate, differentiate and treat diseased tissues via adult epithelial stem cells. Each verb in the content model provides an occasion for interaction. A process derived from professional practice provides a simplistic but coherent account of real scientific procedures, designed for accessibility to the study demographic of secondary school students.

**Game-flow design.** The game is designed to motivate player interaction and learning. Through the iterative design process, the content model is embedded in a world that allows players to interact with the core ideas. The verbs of the content model are translated into key moments in interactive gameplay. *Progenitor X* embodies this process, taking the verbs of the content model and creating a turn-based puzzle game in which players assume the role of a regenerative biologist to prevent a zombie apocalypse. Based on the content model above, *Progenitor* players perform three main actions in game-flow: cultivate (or **start** a cycle of) cells, **treat** them, and then **collect** the resulting target material.



**Figure 2: Progenitor X Game-flow Design**

**Semantic template.** The semantic template defines conceptual windows of interest in the game that represent key moments of learning. It is designed around the intersection of the content model with the game-flow design. The key question for semantic template design is: of all the clicks that players make in the game, which ones indicate learning? The semantic template represents a hypothesis about which in-game actions can generate interesting evidence of learning.

In *Progenitor X*, the semantic template revolves around the *start*, *treat*, and *collect* verbs of the content model. The first sequence of player action is the **cell cycle**, in which players *start*, *treat*, and *collect* a group of vital cells. These new cells are used to create tissue in the next cycle (i.e. **tissue cycle**), where players use the same action sequence. Then comes an **organ cycle**, where the player uses the newly collected tissue to *start*, *treat*, and *collect* their way to a whole, healthy organ.

	A	B	C	D	F	G	
1	In-Game Sequence	Mission	Cycle**	Cell population type (Stage 1)	Treatment tool type (Stage 2)	Collection cell type (Stage 3)	
2	1		1 A. ips	fibroblasts	electroporate	ips	
3	2		1 B. meso i	ips	growth factor	meso	
4	3		1 A. ips ii / C. ecto i	fibroblasts	electroporate	ips	
5	4		1 C. ecto ii	ips	growth factor	ecto	
6	5		2 E. tissue i	meso	N/A	meso / tissue	
7	6		2 E. tissue ii	meso	N/A	meso / tissue	
8	7		2 A. ips iii / D. endo i	fibroblasts	electroporate	ips	
9	8		2 D. endo ii	ips	growth factor	endo	
10	9		2 E. tissue iii	endo	N/A	endo / tissue	
11	10		3 F. organ i	N/A	scan	necrotic tissue	
12	11		3 E. tissue iv	meso	N/A	meso / tissue	
13	12		3 F. organ iii	N/A	scan	necrotic tissue	
14	13		3 A. ips iv / B. meso ii	fibroblasts	electroporate	ips	
15	14		3 B. meso iii	ips	growth factor	meso	
16	15		3 E. tissue v	meso	N/A	meso / tissue	
17			**(A = ips, B-D = diff cells, E = tissue, F = organs)				

**Figure 3: Detailed Semantic Template of Progenitor X**

**Learning telemetry.** The learning telemetry layer collects the data specified by the semantic template and organizes it for analysis. It is a mechanism of the game environment that coordinates the

components of the game world into a sequential data-stream that enables analysts to track player paths across the game-world.

In *Progenitor*, capturing telemetry started with identifying gameplay moments within the semantic template on an event-stream level. Significant click-stream events (over 400) around the action sequence (*start*, *treat*, and *collect*) were documented and flagged for recording. Then, search parameters were constructed, allowing reconstruction of interface cues as context for player actions. Lastly, a query schema was developed to pull the specified event-stream data from the massive database. Ultimately, through synchronizing GBA's semantic template and learning telemetry, we were able to identify and collect three kinds of telemetric action-sequence data: cycle-specific, cumulative, and individual.

The figure consists of three tables representing different types of processed telemetric data output:

- Individual:** A table showing individual player actions. It has columns for Action Type (A), Target (B), and various numerical values (C-E). The data includes entries for IPS1, Meso, Ecto, and Tissue cycles, involving actions like Destroy, Collect, Shock, and Move.
- Cumulative:** A table showing cumulative statistics for each player. It has columns for Player ID (A), Population (I), Total Collect (L), and Grid Destroys (M). The data shows varying levels of activity and success for each player.
- Cycle-Specific:** A table showing specific metrics for each player across different cycles. It has columns for Player ID (A), and various metrics related to cell and tissue destruction, organ collection, and success rates.

Figure 4: Learning Telemetry - Processed Telemetric Data Output

## Data Sources and Evidence

Data analysis required synthesizing learning telemetry data output with additional assessment. Specifically, we added two additional data sources to the core telemetric corpus: an adapted measure of success in gameplay, and data from an isomorphic pre- and post-test.

In order to sort the player data into meaningful patterns, we developed an *efficiency ratio* that measured the number of successful cycle completions by a player over the number of times the cycle was tried. For example, if a player successfully collected the required number of cells in a cycle 2 times, and tried to complete the cycle 5 times, the player's efficiency ratio would be 40%. (The higher the percentage, the more efficient the play.)

$$\text{Efficiency Ratio} = \# \text{ of successes}/\# \text{ of tries}$$

We also aggregated results from the pre- and post- content assessment, which included a series of questions about the stem-cell content model based on consultation with stem cell biologists Dr. James Thomson, Dr. Rupa Shevde, and Dr. Gary Lyons. Here, we specifically looked at change in player performance on content questions as measured before and after gameplay.

## Results

Aggregate results revealed intriguing reasons to look further into the “black box” of the game. First, with an 11% average increase in pre-post content scores, the game seemed to be a noteworthy learning vehicle. Interestingly, the aggregate efficiency ratios told us little about learning outcomes as measured by the post-test. Only in the last organ cycle of the game (the “boss level”) was the efficiency ratio correlated with pre-post gains ( $r = .3219$ ). Thus, by the end mission of the game, being good at the mechanics was associated with learning the content model. However, we were unable to identify overall game mastery (as measured by player efficiency ratio) with content learning (measured by pre-post tests) elsewhere in game-play data. This led us to investigate what was going on with players within the specific game cycles.

	Pre-Post Gains
Total Gameplay	11% average increase (t-test sig = .0098)
Efficiency Ratio	no significant correlation
Boss-level Efficiency Ratio	significant positive correlation ( $r = .3219$ )

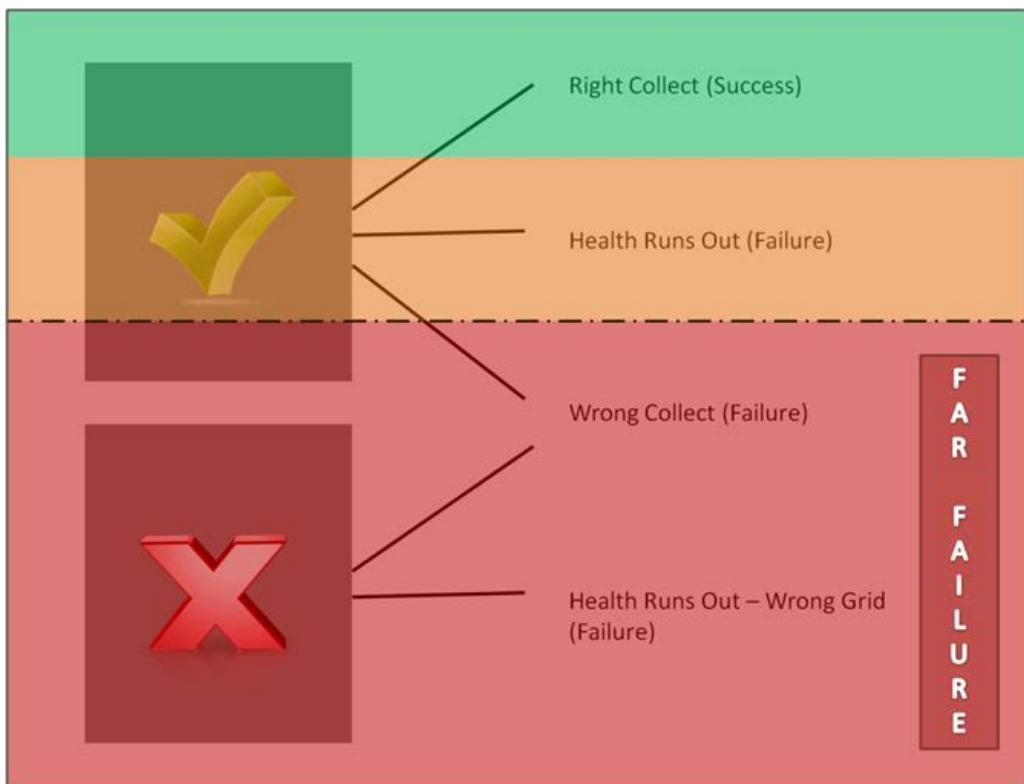
**Table 1: Aggregate Progenitor X Data Summary**

n=39,  $\alpha = .10$

In order to examine player interaction, we mapped all possible cycle outcomes. Within a cycle, players populate (*start*) an initial grid with the right kinds of cells, and then transform those cells (*treat*) into a target cell/tissue to *collect*. After initial population with the right cell, the cycle can end in three ways: collecting the right cell (success), collecting the wrong cell (failure), or over-manipulating/treating the cells so that the Ph becomes toxic (failure).

Additionally, a player could have also initially populated the grid with the wrong cell (see red X in *figure 5*). In this case, there are two options for ending the cycle: collecting the wrong cell, or over-manipulating the cells until the Ph levels (health) becomes toxic.

The possible outcomes imply varying degrees of player compliance with multiple in-game cues (e.g. flashing buttons & in-game narration). To explore this idea, we clustered the types of failures into “near” and “far failure” (*figure 5*). We grouped 3 possible player outcomes: correct collection (successful); correct set-up but health runs out (near failure); incorrect setup and/or incorrect collection (far failure).



**Figure 5: “Far Failure” In Progenitor Gamespace**

The analysis of far failure gave considerable insight into the player data. We found that the total number of “far failures” for players *across all cycles* was significantly negatively correlated with learning as measured by the pre-post tests ( $r = -.2788$ ). Other indicators of play, including the number of cycles started, number of successful collects, and total cycles completed had no correlation with pre-post gains.

To deepen our understanding of far failure, we divided students into quartiles according to pre-post change; the upper quartile had the largest gains in content question scores, while the lower quartile had the smallest. On average, lower quartile students had 7 cycles of “far failure,” while upper quartile students only had 2.3 (difference significant at  $\alpha = .1$ ). Concerning the number of “far failures” and pre-post change, the top students’ were positively correlated, while the lower quartile had strong negative correlation. Since both groups had comparable total NUMBERS of failures, the lower quartile had a greater proportion of “far failures;” thus, the latter’s losses in learning the content may be linked to their lack of responsiveness to the game cues. The pre-post correlation with this number suggests that certain types of failure, not failure itself, inform learning.

	Upper Quartile	Lower Quartile
# of average “far” failure cycles ( $p=.0768$ )	2.3	7
	Sig. + correlation ( $r = .5796$ ) with pre-post	Sig. - correlation ( $r = -.9408$ ) with pre-post
Total failures	No significant difference.	No significant difference.

**Table 2: Summary of Quartile Findings**

\*  $n=20$ ,  $\alpha =$

.10

### **Conclusion and Significance**

The GBA model allowed us to move beyond a simple pre-post comparison of game play to learning outcomes by providing data on how players interacted with the game environment. The design of the semantic template allowed us to collect data at key moments in game-play; the learning telemetry allowed us to tag and assemble these click-stream data points into play profiles we could use for analysis. The resulting data allowed insight into the role of failure in *Progenitor X* game play. Games allow players to experiment with failure without real-world consequences. However, the kinds of failures players experience matter. Productive failure (Kapur, 2008, 2012) suggests that effective learning environments encourage students to activate prior knowledge as a condition for direct instruction. *Progenitor X* introduces players into an unfamiliar subject matter context (regenerative medicine), but in a familiar game-genre context (puzzle-based videogames). Familiarity with the game-conventions invites players to interact with a system in order to learn programmed relationships between cells, tissues, tools and cultures. One interpretation of our analysis is that productive failure happens when players bridge game-mechanic knowledge to content-model knowledge through game-play; non-productive failure happens when players ignore the content model and treat *Progenitor X* solely as a colorful puzzle game with zombies. The richness of the data generated by the GBA will allow us to further explore the relations between player interaction and learning.

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# Multi-Modal Interaction in Digital Instructional Media

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**Abstract:** The current study examines the impact of various multi-modal combinations on the effectiveness of digital instructional media designed to introduce the concept of multiplication. It compares touch and mouse input methods in conjunction with audio and visual feedback in an effort to improve young children's learning in a virtual environment. One hundred forty-one ( $N = 141$ ) first and second grade students played *Puzzle Blocks*, a virtual manipulative designed to introduce students to the concept of multiplication through repetitive addition. The results show that having both auditory narration and a touch experience, in addition to visual feedback, is beneficial for young children's math learning.

## Introduction

Instructional multimedia can be defined as "presenting words and pictures that are intended to promote learning" (Mayer, 2005, p. 3). The relationship between instructional multimedia and learning has been heavily influenced by research in cognitive science. Research has shown that instructional designers working with instructional multimedia should draw on knowledge about human cognition (Bransford, 2000; Low & Sweller, 2005), by optimizing for working memory and the transfer of information into long-term memory (Mayer & Moreno, 2010). A well-established multimedia design principle, the modality principle, also based on models of working memory, states that people learn better from graphics and narration than from graphics and printed text (Low & Sweller, 2005). This principle has been demonstrated by many studies (Kalyuga, Chandler, & Sweller, 2000; Moreno & Mayer, 2000; Mousavi, Low, & Sweller, 1995). While the modality principle mainly emphasizes information processing through visual and auditory channels, there is a movement in cognitive science to grant the body a more central role in shaping the mind (Wilson, 2002). This suggests the modality principle might need to be expanded to include the kinesthetic/motor channel. What are the implications of including the body in the design of multimedia learning environments?

## Theoretical Background

### Working Memory and Multimedia Learning

In recent years, a great deal of research has focused on how multimedia learning environments can be used to promote learning. This work has been largely influenced by current theories of working memory, although the relationship between working memory and long-term memory systems is not fully understood and "continues to drive memory research today" (Thorn & Page, 2009, p. 2). Researchers generally agree that working memory is a limited capacity system, which temporarily maintains and stores information, and supports human thought processes by providing an interface between perception, long-term memory and action (Baddeley, 2003). Recent models of working memory postulate different subsystems that process verbal and non-verbal information separately and independently from one another (Baddeley, 1986; 2000). Baddeley's multi-component model of working memory involves three basic processes including a brain network for the maintenance of auditory and verbal information, a separate network for the maintenance of visual and spatial information, and a central executive network for attentional control and the manipulation of items in working memory (Baddeley, 1986).

### The Modality Effect

The modality effect is "well-established" (Brunken, Plass, & Leutner, 2004, p. 116) and is based on the notion that working memory has two modality-specific slave systems: one for processing visual and spatial information and one for processing acoustic information (Baddeley, 1992). The effect assumes that the manner in which information is presented will affect how well it is learned and remembered. It has been demonstrated that mixed mode presentations of information are more effective than when the same information is presented in a single mode (Low & Sweller, 2005). Low and Sweller (2005) go on to explain that the "instructional version of the modality effect derives from

the split-attention effect, a phenomenon...[that] occurs when multiple sources of information that must be mentally integrated before they can be understood have written (and therefore visual) information presented in spoken (and therefore auditory) form" (p. 147). Brunken and colleagues (2004) write that the underlying assumption is that the "cognitive processing of visually and acoustically presented materials takes place in two separate subsystems of working memory that command separate, independent cognitive resources" (p. 116). Being able to process information using the resources of both subsystems can explain learning outcomes. In other words, when information is presented in two sensory modalities (visual and auditory) rather than one, both slave systems are addressed and total working memory capacity is increased.

## **Embodied Cognition**

While research in multimedia learning has focused largely on how visual and auditory information processing influences learning, research on embodied cognition suggests that the body and its interactions with the world deeply affect cognition. Such research emphasizes sensory and motor systems, suggesting that these systems are essential for successful interaction with the environment (Mahon & Caramazza, 2008; Wilson, 2002). Accordingly, studies in with theories of embodied cognition argue that interaction with the environment through "embodiment" (i.e., physical actions or bodily activity) is an essential part of cognition (Anderson, 2003; Glenberg, 1997; Lakoff, 1987). In recent years, researchers have examined the potential of technology to support embodied activities and ultimately cognition supported by movement.

## **Purpose of the Study**

This study was designed to examine the possible role of the kinesthetic modality on learning. Can the inclusion of a touch-based kinesthetic modality extend the modality effect? More specifically, do kinesthetic interactions in addition to visual and auditory information support young children when it comes to learning a concept such as multiplication in a virtual manipulative learning environment?

## **Method**

### **Participants and Design**

The participants were recruited from public and private schools in a large city located in the northeast of the United States of America. Prior to participation, all participants were required to take a paper-based pre-test to determine their knowledge of addition, a prerequisite skill for multiplication, and their knowledge of multiplication. Students who demonstrated knowledge of multiplication by achieving a score of 50% or higher on the pre-test were dropped from the study. The remaining 141 participants were randomly assigned to one of four groups defined by a  $2 \times 2$  experimental design.

	Audio Narration (A)	No Audio Narration (N)
Finger (F)	N = 39	N = 35
Mouse (M)	N = 34	N = 32

**Table 1: Experimental group design with treatment.**

### **Research Instrument**

To explore the role of modality on learning in an educational game, a video game called *Puzzle Blocks* was designed based on multimedia learning principles. The goal of *Puzzle Blocks* is to reveal a hidden scene by combining groups of blocks. For example, to create a group of six blocks, players build the group of six by adding two-blocks three times ( $2+2+2=6$ ). While players move the blocks, they receive visual feedback about the value of the blocks and the sign of the operator. When a group is complete, players are shown the underlying equation including both factors, the equal sign, and the resulting product (e.g.  $2 \times 3 = 6$ ). In addition to visual feedback, *Puzzle Blocks* also provides auditory feedback. When present, the audio feedback is played at the same time as the visual feedback, providing a one-to-one reinforcement of the information shown visually. The audio consists of a male voice-over that counts and reads the appropriate equations aloud. By experiencing the value of the blocks through both the visual and auditory channels, participants might be able to make the connection between the symbolic blocks, their actions, and the underlying mathematical concepts of grouping and multiplication. How they move the blocks, whether directly on a touch-screen (F), or indirectly with a traditional computer mouse (M), may also impact learning outcomes by mediating the other modalities.



**Figure 1:** The *Puzzle Blocks* Interface.

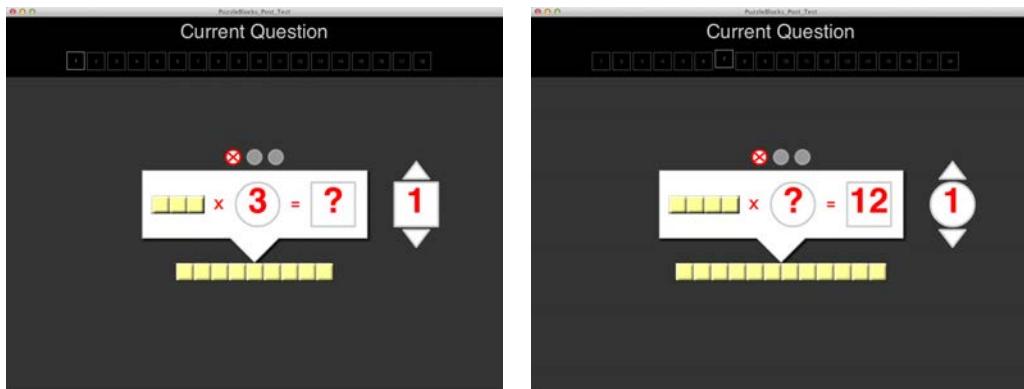
### Procedure

After the pre-test, all students were assigned to one of four experimental groups. Once the groups were assigned, students played *Puzzle Blocks* for five sessions focusing on the two-times table. In each session students played two or three levels, which lasted, on average, between fifteen to twenty minutes. After the first five sessions of game-play, students took a mid-test. Following the mid-test, students played *Puzzle Blocks* again for five more sessions focusing on the three-times table. After the last play session, students took the post-test.

### Materials

Two electronic tests were administered throughout the experiment (mid-test and post-test). The electronic mid-test and post-test consisted of custom software designed by the researchers. Like the virtual manipulative, these digital assessments were deployed on two platforms: a laptop or an iPad. No audio was included. The mid-test electronic assessment presented twelve single-digit whole number multiplication problems that asked for either a missing factor or the product of an equation, such as “ $2 \times ? = 8$ ” or “ $2 \times 6 = ?$ ”. Three problems were from the two-times table and had been “practiced” by participants in the experimental groups. The remaining nine problems were transfer problems in that they had not been seen before in the virtual manipulative environment. All subjects saw the same problems in the same order. The electronic post-test included the twelve questions from the electronic mid-test along with six new transfer questions. No time limit was given and students had three attempts to answer each question.

For each problem presented, a non-interactive group of blocks was shown on the screen as a visual aid (see Figure 2a and 2b).



**Figure 2a:** A “studied” three-times table problem presented in the electronic mid- and post-tests. The non-interactive blocks below the problem provide a visual scaffold to help students find the product.

**Figure 2b:** A “non-studied” four-times table problem presented in the mid- and post-tests. The non-interactive blocks below the problem provide a visual scaffold to help students find the missing factor.

### Results

Students’ mid-test results show that students in all four groups were able to solve multiplication questions without the game environment.

	N	Mean	Std. Dev
AF	39	10.15	2.25
AM	34	8.97	2.43
NF	35	9.92	1.93
NM	32	8.72	2.53

**Table 2: Mid-test Results by Group**

The results of a Profile Analysis indicate that a significant difference exists on the near-transfer mid-test scores between groups,  $F(3, 136) = 3.838, p = .011$ .

Source	SS	df	MS	F	Sig.
Groups	57.677	3	19.226	3.838	0.011*
Error	681.259	136	5.009		
Total	738.936	139			

\*  $p < .05$

**Table 3: Mid-test Results by Group**

In addition, the results of pairwise comparisons between groups found significant differences on the near-transfer mid-test between the AT group and the AM group, between the AT group and the NM group, between the NF group and the AM group, and the NF group and the NM group.

Students' post-test results, however, showed that students' post-test mean scores between groups were not significantly different. The differences were marginal,  $F(3, 136) = 2.408, p = .070$ .

	N	Mean	Std. Dev
AF	39	17.44	1.447
AM	34	16.26	2.937
NF	36	16.53	2.762
NM	32	15.88	3.024

**Table 4: Post-test Results by Group**

	SS	df	MS	F	Sig.
Groups	47.914	3	15.971	2.408	0.070
Error	901.879	136	6.631		
Total	949.793	139			

**Table 5: Post-test Results by Group**

The results of pairwise comparisons revealed significant differences only between the AF and NM groups.

Following these results, the impact of two variables, using fingers (F) vs. a computer mouse (M), and having audio narration (A) vs. not having audio narration (N), were examined. The results of two factor comparisons indicated that the presence of audio narration while playing *Puzzle Blocks* was not a significant factor,  $F(1, 136) = .178, p = .674$ , but using a finger versus a computer mouse was a significant factor,  $F(1, 136) = 11.302, p = .001$ , for the near-transfer mid-test score. Similarly, having audio narration was not a significant factor,  $F(1, 136) = 1.881, p = .172$ , for the near-transfer post-test score, but using a finger on a touchscreen was,  $F(1, 136) = 4.863, p = .029$ . There was no interaction effect between the two factors.

Source	SS	df	MS	F	Sig.
Audio	.891	1	.891	.178	.674
Touch	56.615	1	56.615	11.302	.001***
Audio* Touch	.294	1	.294	.059	.809
Error	681.259	136	5.009		

\*\*\* p < .001

**Table 6: Two-Way Analysis of Variance Results for Effects of Audio Narration and Touchscreen on Mid-test Mean Scores**

Source	SS	df	MS	F	Sig.
Audio	12.474	1	12.474	1.881	.172
Touch	32.250	1	32.250	4.863	.029*
Audio* Touch	1.518	1	1.518	.229	.633
Error	901.879	136	6.631		

\* p < .05

**Table 7: Two-Way Analysis of Variance Results for Effects of Audio Narration and Touchscreen on Post-test Mean Scores**

## Discussion

Recall that the purpose of this study was to examine the impact of various combinations of modalities on learning in a virtual manipulative environment. To explore this topic a virtual manipulative that could be controlled with a mouse or a touchscreen was developed. The results show that all students who used the virtual manipulative gained from the experience. However, the students manipulating the blocks on the touchscreen with their finger showed significantly larger learning gains than students that manipulated the blocks with a computer mouse. In addition, the presence of audio narration seemed to complement, or perhaps supplement, the touchscreen interface, generating even larger learning gains. Ultimately, students manipulating the blocks with their finger and hearing simultaneous narrative feedback showed the largest gains. This finding seems to suggest that multimedia learning researchers should broaden the scope of the modality principle to include not just visual and aurally presented material, but material that can be experienced physically in some way. To the best of the authors' knowledge, this is the first empirical study that shows that combining audio and kinesthetic channels of information results in greater learning outcomes.

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# Beetle Breeders: The Student Experience of a Mobile Biology Game

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**Abstract:** Research shows that educational games can help students build content knowledge and skills, but it can be difficult for teachers to effectively integrate game-based learning into their existing curriculum. UbiqGames are browser-based, casual games that relate directly to the curriculum but can be played outside of class time. Designed for mobile devices, the games can be accessed anywhere, anytime and discussed or analyzed during class. *Beetle Breeders*, focused on the topic of genetics, is one of four games designed to teach intro biology concepts and developed as part of a research study looking at the implementation and effects of UbiqGames. This paper will examine the student experience of the *Beetle Breeders* implementation, including how players integrated the game into their lives both in and out of school, as well as the appeal and effectiveness from a student's point of view.

## The UbiqGames Genre

As the field of educational games research develops, we have come to understand that games can be powerful tools for engaging and motivating students, and are a rich environment for teaching problem-solving skills and content knowledge (Prensky, 2001; Gee, 2003; Shaffer, 2006; Squire 2011). However, effectively integrating game-based instruction into existing curricula remains a challenge for teachers. Classroom time is limited and overcommitted, and access to school-based technology is inconsistent at best. To address these issues while maintaining the value of quality educational games, the MIT Scheller Teacher Education Program has been researching a new model of mobile games for formal education.

Ubiquitous Games (UbiqGames) is a genre designed with unique characteristics that enable students to have a deep learning experience outside of class time, which is then easily connected back to the curriculum. This type of game is designed for the small screens of smartphones so students can use them anytime and anywhere, but its browser-based nature means it can be played on any device. UbiqGames are casual games, meaning they are quick to learn and can be played in relatively short durations of 5-10 minute sessions. This works well for learning games since students can play in frequent, short bursts, during interstitial moments of their day, without taking up precious class time. These games are closely tied to the curriculum and focused on a specific topic. Additionally, they are often simulation-based, giving students the opportunity to engage with the content and explore at their own pace. Player logins enable game data and progress to be stored on a server, which feeds into another key feature of UbiqGames: the Teacher Portal. This unique resource is a web site teachers use to track student progress by viewing player information collected by the data-logging system. Along with game data (score and level), the games also log other types of data that describe play patterns such as how long players spend in each area of the game, how many times they log in, and how well they are progressing in the game.

Equally important to the games themselves is the surrounding implementation model, in which teachers let students experience the game during their own time, then use class time to connect the concepts in the game back to the curriculum, and facilitate discussion around those ideas. Due to their unique design, UbiqGames are meant to engage players and facilitate deep learning, while providing a feasible way for teachers to integrate them into their curricula and lesson plans.

## The UbiqBio Project

The Ubiquitous Games for Biology (UbiqBio) project, funded by a grant from the NIH, is a suite of four games in the UbiqGames genre described above, designed to help high school introductory biology students understand important biology concepts that can be difficult to master. The project encompassed development of four UbiqBio games, covering the topics of Mendelian genetics, protein synthesis, evolution, and food webs, as well as research on the week-long implementation of each game. Biology teachers were consulted throughout the design process to identify misconceptions that students often have, help design standards-aligned games that address those misconceptions, and

develop curriculum materials that facilitate transfer and support other teachers in implementing the games.

The research questions explored in this project pertained to student learning and engagement, as well as teacher adoption and usability. This paper focuses on the student-centered outcomes of one particular game, including:

1. Did students find the game appealing and engaging?
2. What benefits did students perceive in terms of biology content learning?
3. What kind of student-to-student interactions did the game facilitate?
4. Is the UbiqGames model a feasible method for game-based instruction?

Studying these aspects has helped researchers gain insight into the overall student experience of UbiqBio, while also learning more about best practices for the design and implementation of mobile learning games in schools, both now and in the future.

## Beetle Breeders

One of the UbiqBio games developed during the project, *Beetle Breeders* (see Figure 1), focuses on the concepts of Mendelian genetics and inheritance patterns. In this game, players are running a beetle pet shop. Customers want to buy beetles with certain traits and it's the players' job to breed them. They choose the contracts they want to work on, then mate the right beetles to produce the desired offspring. They must use their knowledge of Mendelian genetics to work with increasingly difficult patterns of inheritance and maximize their profits.



**Figure 1:** Beetle Breeders screen shot.

*Beetle Breeders* contained a significant amount of biology content, as players were asked to work their way up through a variety of inheritance patterns including simple dominance, codominance, incomplete dominance, sex-linked traits, and polygenic traits. One of the most valuable experiences in the game was that of breeding beetles of certain genotypes and the ability to immediately see the offspring's resulting genotypes—a puzzle-like exercise that lets players experiment independently with the biology content. In addition, the game reinforced the concepts of probability and randomness by having players fill in Punnett squares and then selecting one genotype at random for each offspring. Overall, the game was designed to draw players into the story and puzzle aspects of the game, while both giving them exposure to new biology concepts and practice with familiar ones.

## Methods

During the spring semester of 2011, a large-scale controlled study of the UbiqBio games and implementation approach was conducted. Participants included six teachers from three different schools in the Boston area, with a total of 177 Intro Biology students. The participant group was comprised of 53% boys and 47% girls. Due to the urban schools chosen as study sites, there was a large minority population, with students self-identifying as 47% Hispanic, 14% African American, 9% mixed race, 7% White, 3% Asian, and the rest unspecified.

The six teachers attended professional development sessions for each game, in which they learned about the gameplay, became comfortable using the smartphones involved, and were trained on the associated curriculum materials. For each relevant unit, teachers loaned Android smartphones (provided by MIT) to their students and assigned as homework for the students to play either a certain amount of time or a certain number of levels. Throughout the week or so of gameplay, they used the Teacher Portal to monitor student progress and tied the game back into their lesson plans where appropriate. Near the end of the unit, they collected the phones back from the students and conducted relevant wrap-up activities to facilitate transfer and help students reflect on their UbiqBio experience. During and after the implementation of each of the four games, researchers used a variety of data collection methods to examine numerous aspects of the students' experience with UbiqBio and *Beetle Breeders*.

Content knowledge gains were measured by an assessment based on existing MCAS (Massachusetts standardized assessment) questions and compared to scores from a control group of students assessed at the same point in the school year, one year prior to the study. Play pattern data was recorded by the back-end data logging system and can be analyzed to reveal when students typically played and how far they advanced in the game. Analyses of these data will be offered in other papers, while this paper will focus on the student experience as described primarily through surveys and interviews.

Upon completion of the *Beetle Breeders* biology unit, teachers administered a brief written post-survey which consisted of 17 closed-response items, the majority of which probed students using a five-point Likert scale. The survey questions gauged students' opinions about *Beetle Breeders*, as well their experiences playing the game.

In addition to the quantitative survey data, student interviews were also conducted for the purpose of collecting supplementary qualitative data. This was done on a much smaller scale, with a handful of students who had played the games and were available to be interviewed throughout the semester. These interviews provided anecdotal data to corroborate and explain from a student's point of view the trends that may be seen in the quantitative data.

## Findings and Discussion

### Experience Playing *Beetle Breeders*

In the UbiqGames model, students not only play games because they are "assigned" by their teacher. Ideally, students play because they find the games engaging and useful. To assess student perceptions, students were asked specific survey questions along these lines. When asked whether or not *Beetle Breeders* was an effective learning tool, the majority of students (76%) felt the game helped them learn genetics. This is not surprising given that the game covers a range of genetics-related biology concepts, and contains content which students can readily see as relevant to their course work. One student commented, "With the Punnett Squares I think that helped me get better with that, to understand it. Because I really didn't get... I've taken this class before and I haven't gotten [it]."

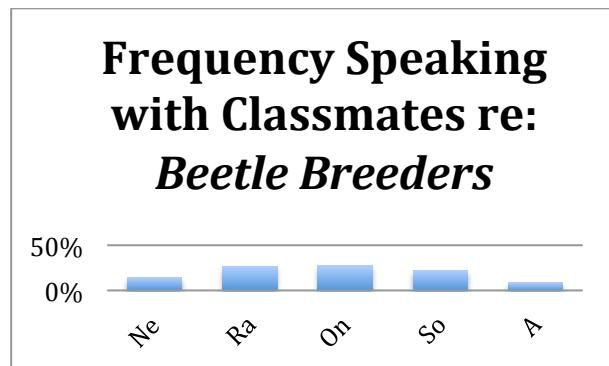
However, only slightly more than half (56%) described *Beetle Breeders* as fun, and nearly half (46%) agreed that the game was confusing. The authors of this paper feel that the design and implementation of *Beetle Breeders* significantly contributed to these mixed responses. Most notably, the technical implementation of the game made the gameplay often tediously slow, and this frustrated students. As one boy commented, "It's just that the phone would go slow when you're playing and I was just like 'oh, forget this,' and I'd just go do something else." Additionally, the game requires players to go through a somewhat complicated series of steps to complete the game tasks, and to be successful in the game, students need to leverage their knowledge of various genetics patterns of inheritance which many students find challenging. The combination of challenging content along with a somewhat intricate (even tedious at times) user interface may account at least in part for why students did not rate the game as more enjoyable. One student explained, "It was really complicated like with the contracts, types of different Beetles mating, like I didn't know if I had to sell it or if I had to keep it. How much money I would get. It was pretty complicated."

The UbiqGames model attempts to provide challenges at an appropriate level of difficulty for the individual student. As students complete levels and demonstrate mastery of concepts, the game

“levels up” and introduces increasingly complex content. Students rated their perception of the game’s level of difficulty for them. While 49% rated this as “just right”, another 31% reported that the game felt too difficult. Again, the authors felt that this was due to the combination of a somewhat intricate series of game mechanics, as well as the content itself. The combination of improved user interface, additional in-game feedback assisting students where they appear to “get stuck”, and where possible, additional peer-peer or teacher-student discussion might improve students’ perceptions. Ideally, games would be, as Papert writes, “hard fun” (Papert, 1996)—challenging enough to maintain focus and engagement, but not so difficult as to overwhelm the student, fail to assist the learning process and divert the student with frustration.

The UbiqGames approach also aimed to strike a difficult balance. On the one hand, the games were to be readily adopted by teachers, fit into students’ lives, and feel relevant to their concurrent school “work”. On the other hand, UbiqGames sought to engage students with a games-based approach (less frequently seen in schools) that effectively utilized technology to personalize the learning experience. Along these lines, students’ opinions were, interestingly, split in their views of *Beetle Breeders*, feeling that *Beetle Breeders* did (45%) or did not (40%) feel like “school.” Similarly, students reported that *Beetle Breeders* did (46%) or did not (29%) feel like “a game.” Given the design and approach of *Beetle Breeders*, these findings are not surprising.

Often, traditional schoolwork (problem sets, individual homework) lacks a social component. Researchers were curious whether or not students discussed *Beetle Breeders* among their classmates. Survey data suggests that students were fairly mixed in the amount they discussed the game with their peers, as displayed in Figure 2.



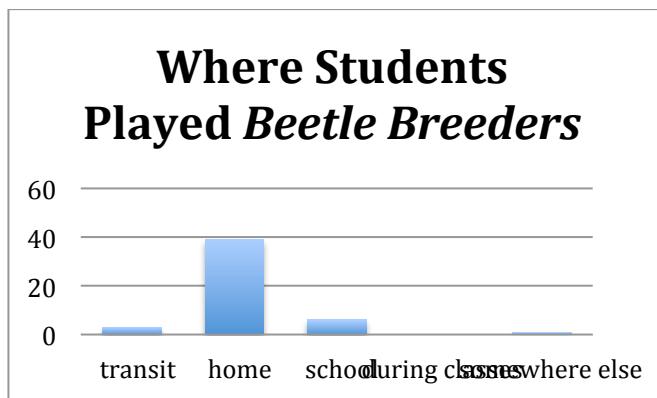
**Figure 2: Frequency Speaking with Classmates.**

When asked about the content of their peer-to-peer discussions (See Fig. 3), the vast majority of discussion focused on either “game tasks” such as how to search and mate beetles, or how much money they had earned, which is the quickest way to assess student “achievement” in the game. While these are valid topics of conversation, the designers of UbiqGames aim to also foster discussion of the game content and strategies for success. Experimentation with “teams” and the positive or negative impacts of a competitive environment, for example, are interesting next areas to explore in the research around fostering student discussion.



**Figure 3: Topics of Peer-to-Peer Discussion.**

UbiqGames are unique in that they are web-based mobile games allowing them to be played across iOS and PC platforms, on desktop and mobile devices. The “casual” game style also permits students to play in short, frequent bursts of time rather than extended sessions, freeing them to potentially play in a variety of locations, which some students did report doing for *Beetle Breeders* (Fig. 4).



**Figure 4: Where Students Played.**

While the majority of students reported playing at home, a few students mentioned playing in other locations. Interestingly, no students reported playing “during classes” in their written surveys. However, during interviews a few students who were trying to beat their classmates admitted to playing briefly during class, even though students were explicitly forbidden to play during class time. Ideally, the designers of UbiqGames hoped that the flexible play patterns would reduce barriers to use. When asked whether they felt “too busy to play”, only 20% reported that this was an issue “frequently” or “all the time” with the vast majority (80%) maintaining that finding time to play was not problematic to any great extent.

With many technology-based educational interventions, there is the possibility that users will run into technical or logistical challenges. This was a concern for designers of the UbiqGames, especially since nearly all students used borrowed cell phones. This meant that the majority of players were both unfamiliar with the hardware/software and unaccustomed to charging, caring for and remembering to carry their UbiqGames device. However, only 5% reported frequent problems with their phone working properly (within which it is unclear if this was due to user error, faulty hardware/software or a combination of the two). The vast majority (83%) reported little or no problems with their devices. Similarly, a mere 4% indicated that they frequently forgot to carry their phones, with 87% reporting little or no problems remembering to bring their devices. Of course, as smart phones become the norm among students these issues will simply fade into the typical patterns of students remembering textbooks, backpacks, and calculators. In fact, one could convincingly argue that the last thing a teenage student will forget would be his or her cell phone.

## Conclusions

UbiqGames generally, and the *Beetle Breeders* UbiqBio game in particular, were designed to investigate whether or not a casual game model could be readily embedded into fairly traditional biology curricula. Results from this study demonstrate that teachers were able to include *Beetle Breeders* with minimal technical and logistical difficulty for teachers and students. Students were generally able to readily use the technology on a practical level.

*Beetle Breeders* was intended to foster student engagement with key genetics concepts beyond those possible with standard paper-and-pencil exercises. Students perceived the game as a useful tool. However, significant challenges including a confusing user-interface and sometimes tedious game mechanics affected the game’s appeal and potentially its value as a learning tool. In future UbiqGames, improvements in user-interface and game designs may provide students with more feedback and therefore reduce confusion and frustration, ideally increasing quantities of time spent playing the games and improving learning outcomes.

Furthermore, the “ecology” of student learning (Klopfer, 2011) consists of in-class instruction, homework, personal interest, class peers, teachers, and everything else in students’ lives (such as

things that distract them from doing their homework). Utilizing a game-based component of learning can nicely dovetail within that ecology. Designs for UbiqGames and related curricula that can leverage multiple facets of that ecology may have an even greater impact on student attitudes and learning outcomes. Future work investigating ways in which UbiqGames successfully permeate this ecology offer many potential lessons for educators seeking to engage students in novel ways.

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# Confirming the Taxonomy of Video Game Enjoyment

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**Abstract:** An empirical taxonomy that details the design features that influence player perception of video games can be a useful tool for guiding the creation of effective gameplay experiences. Building from previous exploratory work in identifying a taxonomy of enjoyment in video games (Quick & Atkinson, 2011; Quick, Atkinson, & Lin, 2012), a follow-up study was conducted to gauge the gameplay preferences of 326 undergraduate learners. A confirmatory factor analysis was employed to validate, refine, and expand the existing taxonomy of video game enjoyment. This analysis confirmed the six previously identified design factors and substantially expanded their specificity by incorporating several new underlying features. The analysis and its resulting taxonomy are presented.

## Introduction

In creating games to meet the needs of specific audiences, it is important to understand how design influences player perceptions of the gameplay experience. A game design can be described by its features. By understanding how certain features influence players' enjoyment of games, designers may be better able to create desirable experiences for players. This is particularly relevant in the field of serious games, where training, learning, health intervention, and other critical benefits are sought through gameplay.

Quick and Atkinson (2011) conducted an exploratory, data-driven study to determine which design features most influence undergraduate learners' enjoyment of video games. They reported a taxonomy of six key design elements, which included Challenge, Companionship, Competition, Exploration, Fantasy, and Fidelity (Quick & Atkinson, 2011; Quick, Atkinson, & Lin, 2012). Each of these design factors was defined by two to five underlying features, such as 3D graphics or exploring unfamiliar places. This taxonomy was compared to several preceding taxonomies of game design, including those offered by Hunnicke, LeBlanc, and Zubeck (2004), Winn (2008), Yee (2006), and King, Delfabbro, & Griffiths (2010), among others. Upon finding strong correspondence between the past and present taxonomies, Quick and Atkinson (2011) concluded that the salient design features that influence player enjoyment are scientifically identifiable and that a convergence around these features was evident, in spite of the varied historical approaches taken to generating game design taxonomies.

A confirmatory follow-up study was conducted to validate the taxonomy of video game enjoyment (Quick & Atkinson, 2011; Quick, Atkinson, & Lin, 2012). In addition, it aimed to further expand and refine the taxonomy. Two primary research questions guided this pursuit.

1. To what extent is the taxonomy of video game enjoyment validated through a confirmatory factor analytic approach?
2. To what extent can the taxonomy of video game enjoyment be expanded and refined through a confirmatory factor analytic approach?

## Method

An online questionnaire was administered to 326 undergraduate learners at a large public university in the southwestern United States. The students came from a variety of disciplines and class levels. All were enrolled in an introductory computer literacy course and earned course credit for participating in the study.

The survey instrument contained 28 items that asked learners how important certain design features are to their enjoyment of video games. The items were scored on a scale from one (*Not at all important*) to five (*A must-have feature*). Eighteen of the items composed the taxonomy presented by Quick and Atkinson (2012). The remaining 10 items were added to expand, reinforce, and further specify the six game design factors. Three example items follow.

- The game is set in a fantasy world.
- The game features lifelike animations.
- The game requires me to cooperate with other players.

Questionnaire responses were examined using a confirmatory factor analytic approach. All analyses were conducted in *R* (R Development Core Team, 2010) using the *Lavaan* package (Rosseel, 2011a, 2011b).

## Results

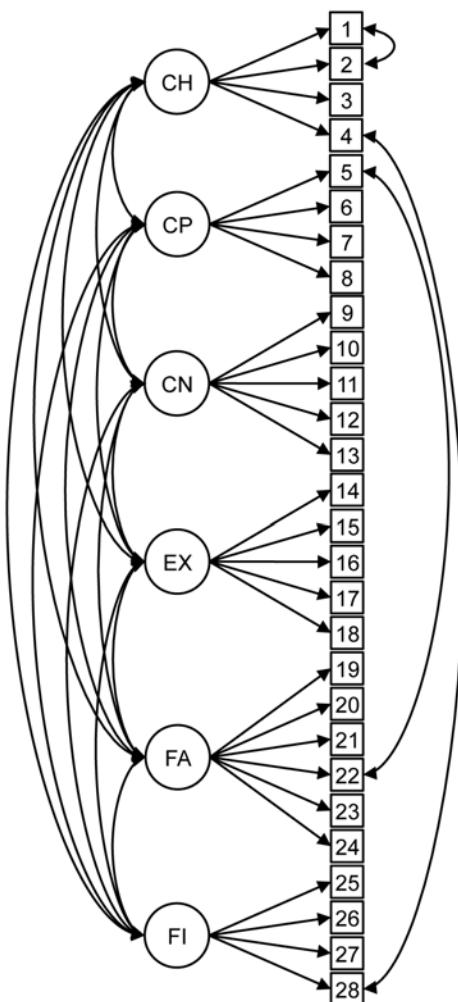
A confirmatory factor analysis was conducted on 326 questionnaire responses. A correlated traits model was examined, whereby a group of correlated latent variables are hypothesized to predict a set of measured variables. In this analysis, a group of six latent variables was hypothesized to predict 28 measured variables. The six latent variables correspond to the six game design factors that influence player enjoyment (Quick & Atkinson, 2011; Quick, Atkinson, & Lin, 2012). The 28 measured variables include the specific features that underlie these design factors and were gauged through the collected questionnaire responses.

This model demonstrated acceptable fit for its sample size and quantity of measured variables, with RMSEA = .058, SRMR = .058, CFI = .921, and  $\chi^2_{(360)} = 758.474$  ( $p < .001$ ). To minimize Type I and Type II errors in identifying misspecified models, Hu and Bentler (1999) suggest a RMSEA < .06, SRMR < .08, and CFI > .95. Meanwhile, Hair, Black, Babin, and Anderson (2010) suggest that a RMSEA ≤ .08, SRMR ≤ .08, and CFI > .92 indicate good fit. Table 1 presents the loadings and standard errors for the model, as well as descriptions of the 28 measured design features. Figure 1 graphically depicts the accepted model. Note that this model contains correlated residuals for three item pairs (1 and 2, 4 and 28, 5 and 22). These paths were freed based on an examination of the model's modification indices. The correlated residuals between these items indicate that additional covariance exists amongst these items that is not fully explained by the model.

Variable	Description	Unstd. Load	Std. Error	Std. Load
<b>Challenge</b>				
1	Difficult to master	1.000		.660
2	Difficult to beat	1.194	.071	.813
3	Challenging difficulty	1.140	.092	.811
4	Obstacles to overcome	1.153	.101	.811
<b>Companionship</b>				
5	Socialize with others	1.000		.755
6	Played by many at parties	.823	.077	.627
7	More than one player	.998	.085	.701
8	Cooperate with others	1.021	.077	.779
<b>Competition</b>				
9	Display skills in public	1.000		.657
10	Best players recognized	1.069	.094	.725
11	Compete against others	1.180	.104	.740
12	Compare skills with others	1.315	.103	.858
13	Play with others online	1.237	.109	.729
<b>Exploration</b>				
14	Explore unfamiliar places	1.000		.708
15	Discover unexpected things	1.062	.079	.813
16	Experiment with strategies	.850	.075	.685
17	Search for hidden things	.978	.086	.678
18	Explore inner workings	.916	.084	.657
<b>Fantasy</b>				
19	Fictional characters	1.000		.649
20	Abilities not from real world	1.235	.110	.727
21	Character other identity	1.308	.115	.740
22	Imaginary creatures	1.321	.103	.845
23	Character other species	1.263	.105	.792
24	Fantasy world setting	1.401	.110	.850

Variable	Description	Unstd. Load	Std. Error	Std. Load
<b>Fidelity</b>				
25	Realistic sound effects	1.000		.720
26	3D graphics	.786	.088	.529
27	Lifelike animations	1.102	.088	.805
28	Realistic graphics	1.055	.084	.800

**Table 1:** Descriptions, unstandardized loadings, standard errors, and completely standardized loadings for the correlated traits model. The first item of each latent variable was fixed to 1.000 to set the scale for the factor. The p-values for all estimated model components are < .001 and are suppressed to reduce redundancy.



**Figure 1:** The correlated traits model describes how the latent factors of Challenge (CH), Companionship (CP), Competition (CN), Exploration (EX), Fantasy (FA), and Fidelity (FI) predict their measured design features (numbered 1 to 28). The error term for each measured variable has been suppressed to improve readability.

## Discussion

This analysis confirmed the overarching factors included in the taxonomy of video game enjoyment (Quick & Atkinson, 2011; Quick, Atkinson, & Lin, 2012). Whereas the original taxonomy was derived through exploratory means, a confirmatory analysis of the same six design features yielded a model with acceptable fit. This provides some evidence that the taxonomy of video game enjoyment is empirically and theoretically sound. In addition, this analysis expanded upon the taxonomy of video game enjoyment by increasing its measured variables to 28. This leads to design factors that are

better defined and likely to be more reliable and valid in continued research and application. From this analysis, the six design features that influence player enjoyment of video games can be described as follows.

- Challenge: The enjoyment of mastering and beating difficult games, overcoming challenging obstacles, and games with challenging difficulty levels.
- Companionship: The enjoyment of socializing and cooperating with others through gameplay, multiplayer games, and games that can be played by many people at parties.
- Competition: The enjoyment of displaying one's skills publicly, competing against and comparing skills with other players, being publicly recognized as the best player, and playing with others online.
- Exploration: The enjoyment of exploring unfamiliar places, discovering unexpected things, searching for hidden things, experimenting with different play strategies, and exploring the inner workings of a game.
- Fantasy: The enjoyment of fantasy worlds, fictional characters, abilities that do not exist in the real world, imaginary creatures, and roleplaying as species and identities other than one's own.
- Fidelity: The enjoyment of realistic graphics and sound effects, 3D graphics, and lifelike animations.

## Conclusion

This analysis has provided confirmatory evidence of the taxonomy of video game enjoyment, which was originally revealed through exploratory work (Quick & Atkinson, 2011; Quick, Atkinson, & Lin, 2012). In addition, it has fortified the six game design factors that influence player enjoyment by increasing the number of underlying characteristics to 28. Continued examination of these data should employ a structural equation modeling approach to test for the existence of an overarching second order latent variable, such as enjoyment, which may be predict the six latent game design factors. Furthermore, multiple structural equation models should be assessed and compared to ensure that the optimal solution is determined. An empirical taxonomy of the features that influence player enjoyment, such as the one presented here, may prove to be an important tool for effective game creation by educators, designers, and other stakeholders in the field of serious games.

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## ***Operation BIOME: The Design of a Situated, Social Constructivist ARG/RPG for Biology Education***

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**Abstract:** The worked example described herein follows the design and development of a year-long, game-based biology curriculum, *Operation BIOME*. Built through a situated cognition theoretical framework, *Operation BIOME* capitalizes on the affordances of gaming rulesets, metacognitive reflection, and social constructivism to prompt a broader and deeper student understanding of science, technology, engineering, and mathematics (STEM). As an alternate-reality game wrapped around a role-playing game, *Operation BIOME* offers players (students) the opportunity to think, act, and behave like real-world scientists in ways that cannot be accomplished through simple science ‘gamification’. This paper explores the benefits of the ARG/RPG structure for biology, specifically, and explains the theoretical underpinnings that make it a desirable, low-tech way to produce favorable student learning outcomes.

The notion of using games as learning tools has existed for millennia, extending backward through time to the beginnings of education itself. As noted by Travis (2011a), Plato’s *The Republic* drew explicit attention to the relationship between ‘playing pretend’ and understanding learning as much as 2,500 years ago. This idea has persisted through educational psychology, influencing the works of Dewey (1938), Bruner (1961, 1966), and Gee (2003), arriving at a point where 3-dimensional, virtual worlds can now mimic real-world activities so well that learners can inquire, explore, and interact with an imaginary environment in ways that directly or nearly directly mirror direct experiences with the real-world. A wide number of studies have discussed the potential of gaming for improving overall student engagement, and while more work is needed to truly understand the power of educational gaming, there is an increasingly pervasive belief that game-based learning can change the way instructors and students interact with science content (Honey & Hilton, 2011; Johnson, Levine, Smith, & Stone, 2010; Johnson, Smith, Willis, Levine, & Haywood, 2011; Young et al., 2012).

Game developers have largely capitalized on the relationship between ‘playing pretend’ and learning in order to successfully market products to their consumer base. While *Grand Theft Auto*, *Super Mario Bros.*, *Halo*, and *Call of Duty* generally do not emphasize learning as a primary player objective, they contain the same basic elements that prompt metacognitive reflection, critical thinking, and problem solving commonly associated with successful academic learning environments. Salen and Zimmerman (2003) argued that these elements, as defining characteristics of the overarching ruleset for a great game, are what make ‘playing pretend’ valuable to the educational process over and above impressive graphics, sound effects, or other superficial qualities. Indeed, games place the player in rich contexts that require thorough exploration and investigation to resolve pre-defined conflicts much in the same way successful K12 and college classrooms do, making them useful for contextualizing information about problem solving in the real world.

Consequently, games have the potential to address the situated nature of learning for the betterment of student achievement outcomes. The core premise of situated cognition poses that interactions between the individual and the environment are the essence of learning, meaning that knowing is an active process rather than a solid block of facts, memories, and other internalized (and non-measurable) entities—that is, knowing is inseparable from doing (Brown, Collins, & Duguid, 1989). In recognition of this fact, Gee (2004) noted that, “deep learning requires an extended commitment [that] is powerfully recruited when people take on a new identity they value and in which they become heavily invested—whether this be a child “being a scientist doing science” in a classroom or an adult taking on a new role at work” (p.18). It would be prudent to address the context issues associated with learning by introducing games as an instructional methodology rather than attempting to modify current ineffective or environmentally impoverished instructional techniques. Given the relationship between game immersion and the desire to have students learn by doing, learning objective achievement may be readily accomplished through the development of game-based environments that transparently parallel real-world environments.

### **Ensuring Rich Situativity of Games for Science Education**

Honey and Hilton (2011) described many of the affordances of game-based learning for science, technology, engineering, and mathematics (STEM) domains in their research for the Committee on Science Learning: Computer Games, Simulations, and Education, but found that while science simulations were a promising means of introducing students to the sciences, games, as a whole, were categorized as ‘inconclusive’ and in need of additional study. Their findings directly align with Young et al.’s (2012) meta-review on trends in video gaming for education in which only 19 empirical studies on video games for math and science could be identified across a total of 362 peer-reviewed publications linking games with academic achievement.

While this signals an important opportunity for educators and game developers alike, the potential for science-based game development and research does not represent a blanket justification for the gamification of STEM domains (i.e., the addition of superficial points, scores, ranks, badges, and/or 3D graphics to the content) (Deterding, 2011). Situated experiences that reflect the act of ‘doing’ science require more than the environment ‘looking’ a certain way or the student using a controller, keyboard, cards, or other gaming tools to make decisions on behalf of a character. Extant STEM gaming research provides little evidence that the use of gamified experiences improve student achievement outcomes, and only a small number of studies identify statistically significant gains in student performance after exposure to gamified science content (Annetta, Minogue, Holmes, and Cheng, 2009; Kennedy-Clark, 2011; Wrzesien and Alcañiz Raya, 2010).

Meaningfully introducing game-based learning into science education requires emphasis on sound pedagogical design and strict adherence to the instructional techniques associated with situated learning. Direct instruction-heavy games have the propensity to bombard players with impoverished, decontextualized information that deviates wildly from the situated paradigm. As Ke (2007, 2008) wrote after experimentation with the gamified math program *ASTRA EAGLE*, “most participants lacked a reflection process for performance analysis, new knowledge generation, evaluation, and integration” (2008, pp. 1615). Additionally, “when facing a poor game design where the learning activities were not deftly veiled within the game world, participants reacted by deeming learning as a foe and chose to simply bypass it” (2008, pp. 1614). The superficial elements promoted through gamification did little to stimulate student reflection, motivation, and self-efficacy toward being a better learner, thus neglecting the affordances that educational games with rich contexts, rulesets, and mechanics can provide as a form of problem-based learning.

Because problem-based learning (PBL) environments introduce students to content via inquiry and experimentation, it is advantageous for educational game developers to construct their offerings as alternate reality games (ARGs) and roleplaying games (RPGs) that rely on student exploration to reach the gaming and learning objectives. When aligned properly, the ARG/RPG PBL environment results in a mapping of game and learning objectives at a 1:1 ratio, creating a learning environment that extends beyond gamification to a context-rich learning experience (Travis and Young, 2010; Travis, 2011b, Young et al., 2012). Bruner’s (1961) work serves as a platform from which educators and game designers may begin developing these kinds of game-based science PBL environments because of its emphasis on the story-telling elements that have facilitated human learning for centuries. Bruner’s belief in the active construction of knowledge promotes teachers as facilitators to learning, assisting students with their movement toward the complex skills defined in the upper tiers of Bloom’s Taxonomy. To achieve the best score, either as students or gamers, learners must organize their cognitive structures in order to assign meaning and organization to new experiences in a given content area (Bruner, 1961; 1966).

To that end, Bruner (1966) suggested adherence to four basic principles to promote the creation of effective constructivist, PBL pedagogy, including: 1) ensuring that the learning environment is experience and context-rich in a way that compels students to learn; 2) ensuring that instruction is well-designed such that it spirals along an accessible, cumulative path toward an end objective; 3) ensuring all learning is deliberately planned to remain open for extrapolation and further study by the learner; and 4) ensuring that all behaviors are reinforced with rewards and punishments to further encourage or discourage them. Game design typically follows these same guidelines, and as emphasized in Gee’s (2003) 36 Learning Principles, both educators and game designers must encourage students and players to become invested in complex, self-directed processes in order to reach the final objectives with which they have been tasked. Ultimately, this is what will allow players

(students) to receive constant feedback from the virtual world regarding their performance, powerfully shaping future learning, problem-solving, and conflict resolution (Rothman, 2010).

### **Operation BIOME: A Worked Example of Continuous Embedded Formative Assessment**

*Operation BIOME*, a year-long, fully expanded biology curriculum, has been built to contextualize life science for the purposes of capitalizing on the educational potency of problem-based learning. The game's narrative structure pairs its embedded game objectives with learning objectives at a 1:1 ratio, thereby scaffolding a framework for continuous formative assessment (Table 1). Because the goals unambiguously require students to roleplay as expert scientists, the learning environment is shifted from teacher-centered to student-centered as the learners work in research groups, construct unique solutions to complex science problems, and directly participate in laboratory procedures. Through a blend of roleplaying game (RPG) and alternate reality game (ARG) elements, *Operation BIOME* enables students to develop creative solutions to authentic problems and promotes the experimental inquiry skills necessary to further their general understanding of biology.

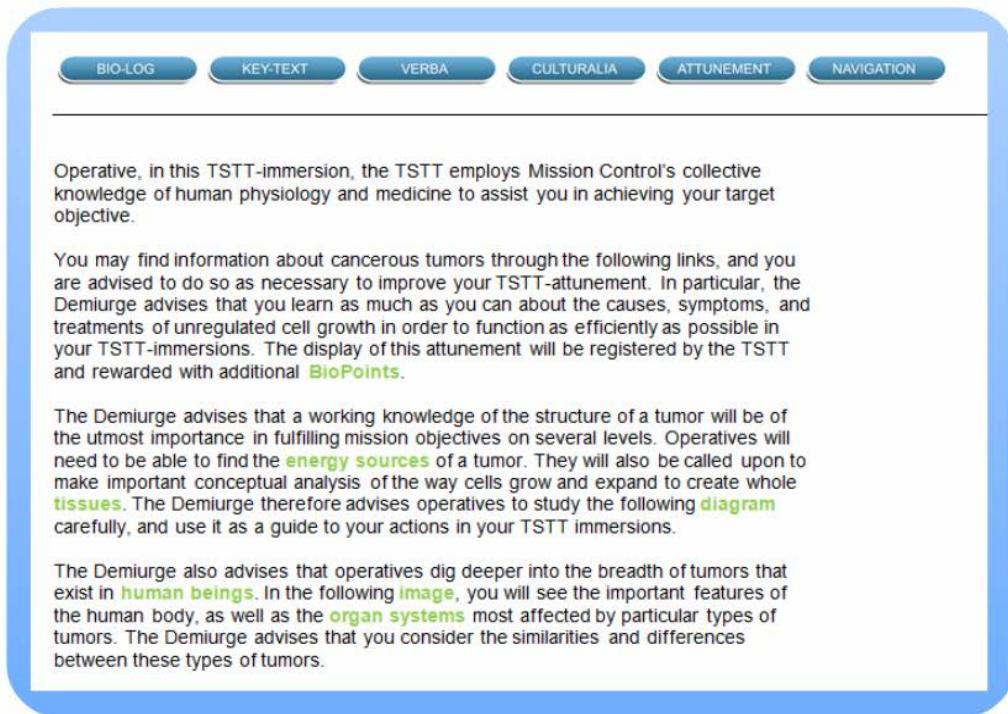
<b>COURSE OBJECTIVE</b>					
<i>Evaluate how DNA serves as the driving mechanism for all life on earth.</i>					
<b>UNIT OBJECTIVE</b>					
<i>Explain how prokaryotic organisms and viruses interact with eukaryotic organisms.</i>					
<b>EPISODE 2.1.a</b>	<b>EPISODE 2.1.b</b>	<b>EPISODE 2.2.a</b>	<b>EPISODE 2.2.b</b>	<b>EPISODE 2.3.a</b>	<b>EPISODE 2.3.b</b>
Compare prokaryotic and eukaryotic organisms	Identify the structural similarities and differences of various bacteria and viruses	Examine how bacterial and viral infections are transmitted	Define and describe the differences between yeasts and other organisms	Explain the role of antibiotics, vaccines, and sanitation in human health	Analyze the role bacteria and viruses play in life processes on earth
Identify the similarities and differences between bacteria and viruses	Describe the processes of binary fission and the lytic cycle	Analyze case studies about patients with various bacterial and viral diseases	Evaluate how microorganisms are used to produce food	Develop preventative measures for protecting against infection	Analyze the role bacteria and viruses play in human disease

**Table 1: Example of Layering Game and Learning Objectives**

The overarching story follows the crew of a fictional space vessel, the USS Van der Waals, headed by the plucky Dr. Cornelius Beakerstink and his graduate students, Autumn and Kalvin. Over the course of eight primary missions, students collaboratively work to recover a legendary artifact, the Genetic Codex, which contains the genetic information of every earthly organism that has ever existed. This makes the end task – interpreting the importance and influence of DNA on all life – the same from both the narrative and scholastic perspectives. While it is not a video game, per se, *Operation BIOME* exists within the framework of online text adventure, an ARG framing the students' day-to-day activities in the classroom and an RPG framing their online interactions with the characters and narrative content. This choice was made partly because a fully virtual world is, in many ways, too confining to adequately fit the needs of a teacher/student and partly because a high technological barrier to entry would prohibit technology-impoverished school districts from participating in its implementation.

Unlike projects that have simply “gamified” science, the developers began with the objectives/standards and used them as a guide for developing the narrative rather than the other way around – a design scheme reflective of the top-down approach often associated with strong curriculum development. 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, critically think, examine existing literature, generate new questions, and, most importantly, collaborate toward realistic shared goals (e.g., “cure cancer”). Additionally, because the narrative follows the same trajectory as state and national standards, the story missions transparently align with the information students need to successfully complete high stakes tests. This means that the narrative is able to carry much of the weight that is usually attributed to direct instruction, allowing teachers to use the exploratory prompts as an introduction to the class content and class time for reflection/discussion of the concepts students are discovering outside the classroom.

The richness of the *Operation BIOME* experience is drawn from the social interactions that take place as a result of student participation in an *Archetype* (game character) team. On a day-to-day basis, each *Archetype* team, composed of three operatives in the ARG framework, enters the RPG through a web browser-based heads-up display (HUD) called the *Texto-Spatio-Temporal Transmitter* (TSTT; hosted via the teacher-student social networking site Edmodo) (Figure 1). The TSTT features a series of immersion sessions that play like media-enhanced text-adventures combined with a fictitious, but deeply science-based, story arc (for more information, see <http://biome.practomime.com>). The HUD in the immersion session contains hyperlinks to resources that the operatives (students) use to research their actions in the immersion-space via Wikipedia, the Discovery Channel, and various scientific journals, and they use their findings to co-construct the learning that occurs in the course.



**Figure 1: The TSTT HUD**

The continuous embedded formative assessment associated with *Operation BIOME* is rooted in the team-controlled *Archetype*. After viewing an objective-based prompt posted in the TSTT by the course instructor (Figure 2), the students collaborate with their teams to decide what actions their *Archetype* character will take in the RPG. This allows the instructor to evaluate the learners' thought processes such that emphasis is placed on the complex cognitive skills associated with being a successful biologist rather than just the *Archetype*'s response product or the basic rote information assessed by high stakes tests.

>Malignancy, City of Leus, Modern Day<

You reach the end of the corridor – a faint breeze chills your skin, and a large, empty chamber opens before you. Dante whispers with urgency.

*This, my friends, is it: Malignancy, bottommost Circle of Hell, and the point where all of Eukaryota's malformed entities are sent to be destroyed. If your villain was going to bring the Codex anywhere, I imagine this would be it. Tread carefully.*

Suddenly, a familiar cackle breaks the chamber's silence.

The shadowy figure stands before you and gestures sharply with its right arm – you hear a shrieking tear as the air is ripped open before your eyes. With unnatural swiftness, the figure dives through the whirling, violet vortex, leaving only a small, glass vial that shatters as it hits the ground. From it sprouts a **tumorous** growth, rapidly expanding to develop bulbous appendages resembling arms and legs. It lumbers toward you, clearly intent on assimilating your body.



**Prompt:** Subdue the Cellraiser.

**Figure 2: Example Mission Prompt**

A typical Archetype dialogue for the prompt “*Subdue the Cellraiser*” might resemble the following:

*Student 1:* Hey guys, the new prompt was posted: “Subdue the Cellraiser.” The last few prompts were about transcription and translation...We could focus on that. (Oh, and we could get bonus experience if we stop the Cellraiser using something from our worldview since transcription and translation deal with DNA.) So again, our worldview is in our PERSONA. It says: “Your character is a highly capable, but modest, young woman. She is devoted to her work on studying microscopic structures via their genetic code. She would like a chance to verify her historic work by handling and experimenting with the codex in person.”

*Student 2:* This prompt is perfect for Rosa, plus we can talk about stuff we did earlier too! Cause our skill is that we can x-ray stuff, maybe we could see if there’s a weak point inside like an artery or something. If there is, maybe we can cut it off to stop the O<sub>2</sub> supply to the cells so they starve and can’t divide anymore.

*Student 3:* Good idea. The key-text stuff also talked about radiation as one way to stop cancer. This thing is probably gonna keep getting bigger, so the sooner we kill it, the better. Maybe we should work on ending transcription and translation as a way to slow it down. We could break down and ruin the DNA with radiation so the thing won’t be able to catch us, and then get rid of the blood supply to finish it off. We should check the links on the key-text again to find more information before we make our lead op post.

The student-to-student instruction conducted within the HUD allows the course instructor to facilitate the correction of misconceptions in real-time rather than providing direct instruction and waiting for summative assessments to dictate end of unit or whole course achievement. Feedback may include veiled critiquing through a character in the game’s plot or direct intervention as the course instructor:

*Teacher:* Operatives, your thinking appears to be on track. You may want to consider reviewing the Culturalia again to get an idea of what will happen should you use the methods you’re discussing (surgery and radiation) to treat the Cellraiser. There are some helpful links embedded in there that will lead you

to American Cancer Society and the National Institute of Health for more information. Before making your team post, I recommend you consider the following questions: are there any side effects for patients who receive radiation therapy? How and why would therapies need to be combined to be more effective? How might the other Archetypes' special abilities complement what you're planning on doing to treat the tumor? I will continue to monitor your progress. Best of luck. Demiurge Epsilon out.

The long-term assessment of critical thinking and problem-solving occurs almost exclusively within online, personalized grading sheets hosted via Google Documents that the instructor uses to tabulate numerical grades via BioPoints (i.e., experience points, BP/XP). These templates act as a Research Description Framework Site Summary (RSS) feed of student growth and allow the teacher to provide pointed feedback about each online student interaction, thus affording a more robust assessment structure than is available through traditional forms of testing. Summative assessments exist as major prompts that focus on knowledge gains by placing learners in complex, problem-rich contexts that require application, creativity, and self-evaluation of learning. This permits the teacher to emphasize and evaluate action on all tiers of Bloom's Taxonomy rather than focusing on one or two at a time. In sum, the assessment process exemplifies the constructivist nature of the program by allowing students to piece together on-going portfolios that establish longitudinal, experiential knowledge growth over the breadth of the biology course, exhibiting the cumulative spiral effect described in Bruner's four governing principles of constructivist instruction (Young et al., 2012).

*Operation BIOME* utilizes the fundamental psychological principles that govern all games, including operant conditioning, constructivism, and social constructivism, to provide learners with engaging situated experiences that promote social collaboration, increase self-efficacy for "doing" science, build intrinsic motivation to continue studying the subject, and, most importantly, offer a data rich source of continuous embedded formative assessment. The underlying RPG and ARG rulesets governing gameplay emphasize the strengths of social learning and instructor facilitation in order to ensure that content mastery within the game's parameters can be applied in actual science settings such as laboratories or the field, thus reflecting the role played by actual scientists, mathematicians, and engineers in the real world.

### **Leveling Up Biology Education**

*Operation BIOME* coalesces many well-documented elements of learning psychology into a powerful tool for structuring situated science education. Its application in the K12 biology classroom may prove to be a highly effective way to supplement and enrich high stakes and other forms of standardized testing so that educators can draw more meaningful conclusions about the student populations they teach. The overarching purpose of schooling has evolved from one of rote memorization to the development of highly complex cognitive skills necessary to remain competitive in a global, 21<sup>st</sup> century community. However, the practical implementation of game-based learning as a form of continuous embedded formative assessment will require the unadulterated passion of instructors dedicated to the expansion of accepted pedagogy. *Operation BIOME* can assist in ushering a transformation in pedagogical design that encourages teachers to craft stories that fit their curricula, seamlessly binding instructional objectives with the composite features of games that have given them lasting recreational appeal. With a revised, comprehensive, dual-formative-summative system of student assessment, educators will be able to generate a much clearer picture of what is expected of their students and, ultimately, create a new generation of life-long learners capable of complex, creative thought in the STEM fields.

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# **Developing Games That Can Create Real Heroes on Real Guitars: Using Acoustic Musical Instruments and the Human Voice as Controllers**

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**Abstract:** Games, one of the most popular forms of entertainment for young people today, exhibit a number of promising traits for pedagogical practice. Game-based learning theory identifies elements of game play that encourage engagement and increased motivation. The acquisition of musical skills on a new instrument can be a slow and laborious process, requiring sustained effort and commitment. A strong alignment between many of the properties of game-based learning and the practice of learning to play a new instrument, especially at the early stages, is identified. After laying out the theoretical connection, a collection of new game design prototypes are described, designed with the goal of augmenting conventional skill-acquisition practice and increasing student motivation and engagement.

## **Introduction**

Learning to play a musical instrument, as with any physical skill acquisition, typically involves thousands of hours of repetitive tasks in the form of etudes and studies. While this practice is considered very beneficial and leads to long-term rewards, the immediate experience is often mundane and students struggle to find the motivation to sustain the required time commitment.

Strong cases have been made for exploring video games as new interfaces for music education (Denis & Jouvelot, 2004). Games are lauded for their ability to immerse and engage players, increase motivation, improve the transfer of pedagogical knowledge, and increase accessibility to resources. Further, there is strong evidence that games foster the development of useful motor, cognitive, and social skills. Games such as Rock Band, Guitar Hero, and Wii Music already boast a modicum of musical, physical skill focus, albeit using specialized game controllers and highly constrained musical contexts. Can video games be leveraged to support musical skill acquisition on traditional acoustic instruments, encouraging long-term musical development?

We present here a preliminary study in music practice-based video game development targeting the early stages of instrument (or vocal) practice. Based on theories of game-based learning (GBL) we designed and created three interactive games aligning educational objectives with the strengths presented by game interactions. Unlike most musical video games developed to date we leverage the student's chosen acoustic instrument or voice as a game controller, ensuring that the motor skills are developed directly upon the instrument or voice of choice. The prototype games were then tested with a group of college students engaged in learning secondary instruments to better understand how these games function with regards to user engagement.

## **Game Based Learning**

While the exploration of video games as tools for music education has been proposed (Denis & Jouvelot, 2004), much work remains to be done in this area. A fundamental challenge facing this exploration involves aligning the affordances of GBL with specific educational goals. We base our exploratory designs in theories of GBL, taking advantage of the opportunities presented by medium as we perceive mappings to existing pedagogical practices and objectives. Towards this end we ask: how do skill centered music education goals align with the strengths of GBL? We now present a number of acknowledged attributes and qualities of games and how we place them in our designs in order to encourage musical practice and development.

First, digital games are found to create meaningful problem-solving experiences, and promote learning-by-doing active and collaborative learning (Huang & Johnson, 2009). This is seen in the process of identifying winning game strategies, typically by learning from mistakes and the mistakes of peers. The improvement of appropriate skills occurs through problem-solving experiences explored by self-directed trial-and-error activities. In commercial games the problems solved rarely have a real-life extension, however in an educational game they could encourage skills that have meaning outside

of the context of the game. What if the problem requires playing a certain melodic passage, or improvising around a given scale or chord sequence? These types of problems map readily to game based challenges.

The development of fine motor skills, often to very high degrees, is seen in the repetitive use of popular video game controllers. One potential opportunity for music game developers is to replace the game controller with the student's chosen musical instrument. Even if the instrument is simply treated as a set of buttons (mimicking a game controller's functionality) the learner is now spending time with their instrument, a desirable educational goal. However, if appropriate use of the instrument is required in order to interface with the game (i.e. playing music, and playing it effectively), the player develops the targeted skills and the game can begin to lead the player through dynamic opportunities for the kinds of development typically confined to static etudes and studies.

If the player is using their own instruments to play the game, the safe spaces for play, experimentation, and failure that games create become of key importance. The "magic-circle" (Huizinga, 2003) surrounding game play encourages exploration that could have detrimental implications in other contexts. In a game there is always an opportunity to try again, and there are no permanent test scores or grades. Thus any failure becomes a step along the path to achievement. Music practice typically encompasses countless failures (missed notes, reading errors, intonation problems, etc.) with many such mistakes before mastery is achieved. We see a strong potential for encouraging productive mistakes and corrections in game-based music education learning. Unlike standard isolated practice settings, a game can offer the player feedback and reinforcement directly and immediately.

Games allow players to carry out actions autonomously in the process of completing game tasks. In other words, players have a great amount of control over what paths they take in order to resolve the problem or task at hand. This autonomy helps players develop a sense of ownership of decisions they make during the game play (Bennett & Warnock, 2007, Crawford, 1982).

In order to encourage engagement with the game, leading to increased musical engagement (i.e. more practice time), the problems and challenges in the game must be perceived as achievable yet somewhat unpredictable, and thus interesting. Ideally these challenges will stretch and flex the player's existing knowledge or skill levels (Pivec et al., 2003), only minimally exceeding the learner's potential capacity to overcome the obstacles (otherwise the learner may experience frustration (Bennett & Warnock, 2007, Crawford, 1982). This is a fundamental problem in all game design and also familiar to educators through Lev Vygotsky's notion of a *zone of proximal development*, and in a musical setting is compounded by the need to balance both in-game problem difficulty with the proficiency of the player's musical capabilities. Yet this simultaneously implies a game progression that starts with entry-level basics and culminates in master level concerti.

Interactivity is a fundamental component of video games, encouraging engagement and immersion, and rewarding experimentation and theory formation leading to meaningful game play (Ang, 2008). While games have been shown to enhance motivation (Pivec et al., 2003), interacting through a musical instrument could simultaneously encourage increased engagement with the instrument, both during and after the game play session. Interactivity might also lead to new models for teaching music theory, allowing the learners to intuit musical rules and properties at their own pace. Additionally, game play seems well suited to modeling and encouraging improvisation (Denis & Jouvelot, 2004), one of the National Standards for music education, both due to the dynamism of the interaction and games' ability to foster a sense of freedom and playfulness.

Competition is a defining characteristic of games (Csikszentmihalyi, 1991) encouraging both engagement and achievement. Players both compete with themselves, through measures of their increasing accomplishments, as well as with other players. This also directly parallels the competitive attitude of the contemporary music market, from solo competitions and opera auditions to college applications and orchestral job opportunities.

Through game play, learners are able to gain first-hand experience practicing a methodology to solve both artificial and real challenges. This is enforced by the rules of the game, which are applied uniformly and constantly to all participants (Crawford, 1982). In a musical context this is analogous to

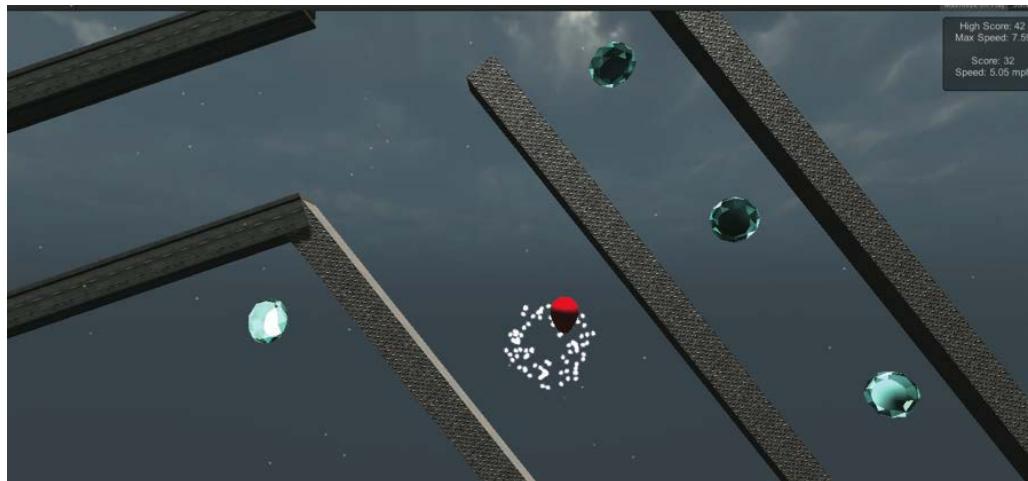
having a music instructor that fairly and untiringly stops on every mistake. At the same time this instructor also consistently and even-handedly rewards every achievement.

While musical achievement typically has no end goal (but may encompass many short-term goals), games fundamentally contain goals and winning conditions. Achieving those game-based goals is accomplished through sequential task completion. This model fits well with musical instruction that necessarily requires sequential practice towards skill acquisition targets (i.e. one must hold the instrument, then learn to make sound, then produce each tone, then play a simple melody, etc.).

### Three Games

In our approach to exploring the application of skill oriented GBL applications in music education we constructed three families of prototype games each addressing specific learning goals, where each family consists of a number of incremental design choices around the same game play themes. The identified learning goals are taken from introductory lesson plans as taught privately and in-group instrument classes. These are: pitch-altitude metaphor acquisition, tone production and sustain, and pitch matching. The first involves learning that pitches with faster frequencies are "higher" than notes with slower frequencies. Good tone production is important to all instruments and a common practice technique, especially for wind instruments, is the sounding of long tones—sustaining a given note as evenly as possible for as long as possible. Finally, pitch matching is a common aural skill that requires the student to accurately repeat a pitch (or pitch sequence) played by an instructor.

The games were implemented in Unity 3D and Max 5. Real-time pitch detection is performed in Max and the resulting data is transformed into a control stream for the game. Continuous pitch, loudness, brightness, and noisiness are all employed to give a general sense of timbre and dynamics in addition to melodic content. Thus any voice or instrument capable of acoustic tone production may be employed as a controller for these games.



**Figure 1: Balloons game play session in progress.**

### Balloons

This game family involves playing a melodic passage in order to navigate a balloon through a series of obstacles (see figure 1). However, this is not stated explicitly, rather the player is presented with the ability to inflate and deflate a virtual balloon based on the pitch they play, which encourages the balloon to rise (for higher pitches) or fall (for lower pitches) and move from left to right on the screen (in conventional "side-scroller" style). Obstacles are placed throughout that require the player to sound a specific pitch sequence in order to progress. By the time the player reaches the end of the level they have played a short piece of music.

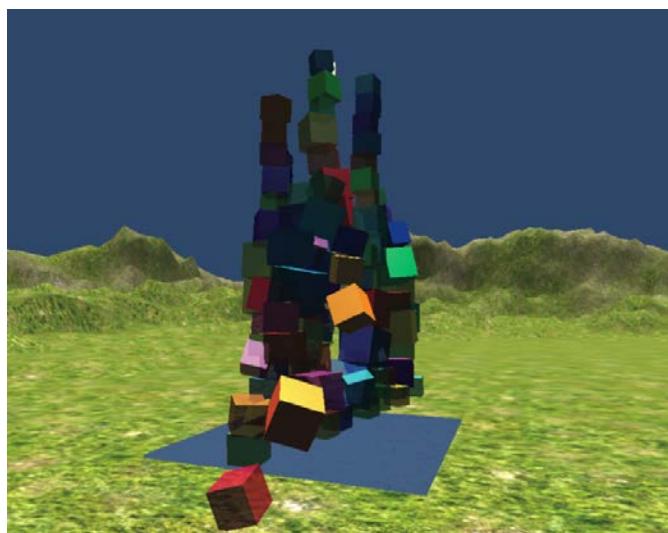
A meaningful challenge is provided to the students through the production of a piece of music presented in an abstract fashion. The notes that comprise the *piece qua level* are only visible as a path through the game space, and thus experimentation encouraged and required in order to discover

the melody. Failure and errors, through playing the wrong notes, causes the balloon to collide with obstacles and lose momentum, suffering a temporary setback. The balloon then floats aimlessly until the proper inflation level (correct pitch) is achieved and progress through the piece resumes. A score is awarded based on the time the player took to complete the level, which is intended to encourage competition and additional challenge as the learner seeks to improve upon their previous attempts.

The layouts (i.e. levels or musical pieces) implemented in the prototype explore both constrained melodic possibilities (i.e. only a single melody can solve the challenge) as well as open pathways (allowing many different successful pitch sequences). The latter are additionally augmented with special collectible objects in the game that count towards a high score, rewarding the player for seeking out more difficult paths/melodies (i.e. requiring more musical dexterity). Also, the more open levels explicitly encourage melodic exploration and improvisation, enabling a number of permutations to solve the same game play challenge.

### **The Long Tone, Long Jump**

Sustaining long tones is typically a key developmental target for the beginning instrumentalist. Towards this goal we appropriated the metaphor of a long jump, in which the player must sustain a note evenly in order to achieve the longest jump and thus the highest score. When the player first articulates a note a colored ball is launched from the left side of the screen, moving rapidly towards the right. As long as the player sustains the tone, with minimal pitch, dynamic and timbre variation, the ball continues to hurtle forward, moving through clouds. When the player finally loses the tone, or 'cracks,' the ball falls to the ground, producing a tangible measure of the length of the tone. The game traces the path of the ball on the background and places a visible mark at the touch down point, simultaneously announcing the player's achievement as measured in virtual meters.



**Figure 2: Musical Towers game play session.**

The explicit extra-game challenge here is to sustain a tone as evenly as possible for the greatest duration, driven by the in-game challenge of flying for the longest attainable distance. Elements of competition are present in the athletic metaphor of the game and the primary challenge is one of educational merit. Failure simply resets the player to the start to try again, and the player may choose any note they desire. The musical metaphor of "high" and "low" pitch is again incorporated, here reflected in the nominal flying altitude of the ball.

### **Musical Towers, Musical World**

The final design family focuses on the aural musical skill of pitch matching: hearing and reproducing a given pitch. Two different visual metaphors are employed for the same educational goal, one that is based on constructing towers of greater and greater height (see figure 2), the other on building a bigger and bigger ball (or world). Periodically, a block appears on the screen and a tone is heard. The player then has a few seconds to match the pitch of the tone with their instrument (or voice), causing the block to become a permanent part of the scene. If the player fails to produce the given pitch the

block explodes, disturbing nearby blocks that may have been acquired previously. Blocks, which are drawn from simple solid shapes, operate within a physical simulation, falling to rest (in the Tower version) or being attracted to nearby blocks (in the World version). The objective is to build the tallest tower or biggest world possible, by correctly matching each tone as quickly as possible and avoiding the disruptive detonations.

The game begins with a basic level of difficulty, and allows the player to try as many notes as they desire in order to locate the correct one (the block changes color to indicate a successful match). However, as the player acquires more blocks (successfully matching more notes) the blocks appear more quickly, intensifying the game play and requiring progressively more accurate pitch matching. This is a classic game design technique that effectively sweeps across the range of targeted skill levels, allowing each player to locate a comfort zone and then encourage them to achieve further. Awarding high scores based on the height of the towers or radius of the worlds again encourages competition and provides an indirect measure of each player's competency at matching pitches on their chosen instrument.

The notes chosen in the game are selected from a preset scale and mode, which can be chosen by the player (or instructor) before the game starts. The pitches are chosen at random in the current implementations, but including more intelligence and the ability to choose pre-loaded melodies is a development target.

### Evaluation

In order to better understand the motivational characteristics of our games a small user study was conducted with undergraduate music students enrolled in secondary instrument classes (i.e. studying instruments on which they have no, or limited, prior experience). The participants employed their secondary instruments to play the games, and occasionally elected to sing (none of the participants had extensive training on the voice). The games were set up and introduced to the students as a group, after which they were allowed to play the games in an ad-hoc fashion. This setting was constructed in order to provide initial observations about the group interactions afforded by the interactive games. Detailed results from this study are forthcoming, however some anecdotal results are presented here.

As anticipated, study participants were able to quickly understand the musical controls of the games and, in almost all cases, play successfully independently of instrumental competency. The Long Tone Long Jump was initially confusing, as the connection between steady tone and ball speed was not readily apparent. While overly sensitive audio processing and game mechanics caused the ball to crash frequently and in a disappointing fashion for some players, other participants were able to reach the "kill screen," successfully flying past the end of the level. Overall, the Long Tone Long Jump appeared to be successful at fostering a sense of friendly competition, encouraging the participants to compare their jump lengths with others (something we hope to further encourage with the addition of high score charts).

Musical Towers seemed to excite some participants more than others, and primarily lead participants to sing (rather than play on their instruments). Additionally, one participant tried their *primary* instrument and found the game enjoyable, indicating a significantly higher required degree of proficiency. While successful, the participants typically sang the pitch in an alternating rhythm with the game, resulting in a slower speed than their actual pitch recognition. This resulted in bigger blocks and a more unstable tower, ultimately leading to an early defeat. While this may be deemed a feature (some participants found this game "soothing"), a more unpredictable game rhythm that more explicitly rewards rapid response will be incorporated and tested in a future version.

The Balloons game proved varyingly difficult for the players, with some being able to navigate the scenes much better than others. In one extreme case a beginning trumpet player, who could only produce three pitches, was quickly frustrated as the game design relies on the production of a full octave. This lead to plans to introduce an adjustable input range, allowing a breadth of competencies from the three note beginner to the four-octave professional.

### Conclusion

We have presented many of the primary features of GBL and how we perceive mapping to music education practice in these specific design prototypes. Further, our three preliminary game designs

seem to align well with these features and provide a platform for testing and evaluation of both the designs and the potential for GBL in skill-based music education. Evaluative work is underway with user testing of the prototype games and future development is planned to incorporate the testing results in improved designs.

There is strong potential for the incorporation of GBL music games in conventional educational settings, in both private and group practice. The rapid feedback afforded by games such as the ones described here may have significant impact in private practice, where the student is typically the sole listener, being required to produce the music and critique it simultaneously. While expert musicians can do this fluently it is an extreme challenge for the beginner, and often results in the incidental acquisition of undesirable habits which require significant effort to relearn. An automated music tutor, integrated transparently in the form of a game, could alleviate these problems.

Group and private practice demands a high degree of commitment from students, due to the large number of required hours, and motivation is always at a premium. Games thrive on competition (Csikszentmihalyi, 1991) and this can also be a significant motivator for many students (as exhibited by the widespread practice of annual regional music competitions and auditioned "all-state" ensembles). GBL may be able to instill an atmosphere of fun engagement through competition, allowing students in a class to go "head to head" in meaningful yet harmless challenges. This mode of play is foundational in the success of games such as Rock Band and Guitar Hero and leveraging the same in a music class setting could be significant.

Finally, GBL presents a strong potential for the discovery of new modalities of music education, fostering new practices around these new tools. Game play may also lead to new ways of imparting theoretical knowledge, enabling a more discovery-oriented model that is typically unavailable in conventional text book-based modes of scholarship. The possibility of student's appropriating these types of games and constructing their own "practice" regimen (i.e. play time) could have wide reaching effects. What could happen if student's invested their game play time, on average 20 minutes a day (Fullerton et al., 2008, with many cases being much higher) into practical, musical games? We believe the results could be transformational.

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# Internet Scale Experimental Design and Deployment for Educational Games using BrainPOP®

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**Abstract:** Large-scale online design experiments (A/B testing, multivariate testing, etc.) are increasingly important for online gaming sites that seek to optimize game mechanics, but for most developers the ability to collect data and run experiments requires custom experimentation and data logging systems. We present an approach that combines a novel digital number line game and a free game portal popular among teachers and students to allow multiple experiments to be executed simultaneously. A pilot study conducted over six months resulted in the collection of millions of data points representing hundreds of thousands of participants in dozens of experimental conditions. These results indicate that this approach can be successfully implemented at a large-scale. Furthermore, analysis of player logfile data revealed insights into learning and game play that can inform the next round of experiments creating a continuous feedback loop. Finally, limitations of the study as well as future work are discussed.

## Introduction

Games for learning are a hot area for research and funding, but it is often unclear what learning is taking place. To what extent can learning be measured during gameplay? One approach is to collect log file data and analyze it using pre-determined engagement and learning metrics. Once that has been established, it then becomes possible to conduct multivariate tuning to optimize learning and engagement. However, performing online A/B experiments in the lab or classroom do not involve numbers of subjects that could sufficiently power comparison studies that may involve upwards of 20 conditions. In this paper, we describe our method of wide-scale online experimentation, using a popular online educational game portal among schools called BrainPOP's GameUp™ as an integral part of our experimental framework to optimize specific design features in a novel digital math fractions game. We also report on our implementation of an online "design experiment," comprising dozens of conditions, hundreds of thousands of participants and over a million unique trials. Finally, we briefly discuss the limitations of such experiments and how insights made at this level can then be used to inform smaller scale lab or school level experiments to validate the results.

## Background and Related Work

While the preschool and kindergarten years are a crucial time to help children develop a conceptual foundation for whole number sense (Baroody, Bajwa, & Eiland, 2009; Griffin, 2004), the ability to approximate magnitudes of complex numbers, such as fractions and decimals, becomes important starting in the 3rd grade (Common Core State Standards Initiative, 2011). Results from both national assessments and smaller-scale studies indicate that demonstrating good "fraction sense" is an important foundational skill that is lacking in many students. The 2004 National Assessment of Educational Progress assessment indicated that only half of 8th-graders were able to correctly order three fractions from least to greatest (NCTM, 2007). Furthermore, when presented with the problem "What is the best estimate of  $12/13 + 7/8$ ?" the majority of a nationally representative sample of U.S. eighth graders chose 19 and 21 rather than 2 (Carpenter, Corbett, Kepner, Lindquist, & Reys, 1981). Difficulties in dealing with fractions have led the National Mathematics Advisory Panel (2008) to conclude "The most important foundational skill not presently developed appears to be proficiency with fractions (including decimals, percent, and negative fractions). The teaching of fractions must be acknowledged as critically important and improved before an increase in student achievement in algebra can be expected" (p. 18).

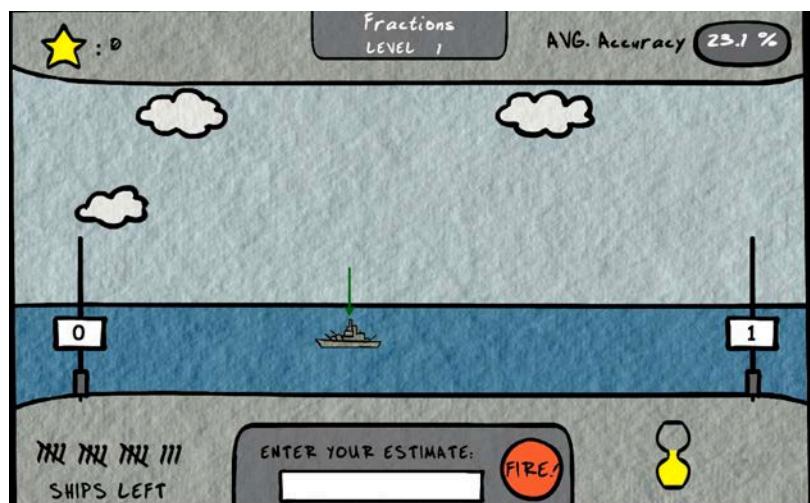
In 2010, responding to numerous studies describing the challenges faced by American students in fractions learning, the Institute for Education Sciences released a practice guide that strongly advocated for the use of number lines for improving students' understanding of fractions (Siegler et

al., 2010). Number lines are a common instructional tool in Asian countries (Ma, 1999; Moseley, Okamoto, & Ishida, 2007; Watanabe, 2006). They may also be used as assessment tools for measuring number sense. Notably, recent work by Siegler, Thompson, and Schneider (2011) shows that the accuracy of number line estimation with fractions correlates with standardized test scores in 6-8th grade. This finding extends prior research on number line estimation with decimals (Schneider, Grabner, & Paetsch, 2009) and whole numbers (Booth & Siegler, 2008), which found that accuracy predicted standardized test scores in grades K-5.

Given the strong relationship between number line estimation accuracy and math achievement, it is interesting to consider whether or not a computer-based number line game may help improve math understanding. Such games have been used to investigate motivational features of learning environments (Malone, 1981) and to improve conceptual knowledge of fractions (Dugdale & Kibbey, 1975; Math Snacks, 2010). In one study by Rittle-Johnson, Siegler and Alibali (2001), a simple digital game called Catch the Monster provided practice in estimating the location of decimals on a number line. The authors found that improving number line estimation accuracy transferred to other conceptual skills, such as the ability to compare the magnitudes of different decimal values. Also, providing an engaging way for students to identify the location of fractional magnitudes on a number line should help clarify the relationship between fractions and whole numbers. In the next section, we describe a computer game that was developed to support number line estimation accuracy.

### Battleship Numberline

*Battleship Numberline (BSNL)* is a Flash-based number line game designed to help students develop an accurate and integrated understanding of “number sense,” which is defined as “the ability to approximate numerical magnitudes” (Booth & Siegler, 2006). A screen shot of *BSNL* can be seen in Figure 1.



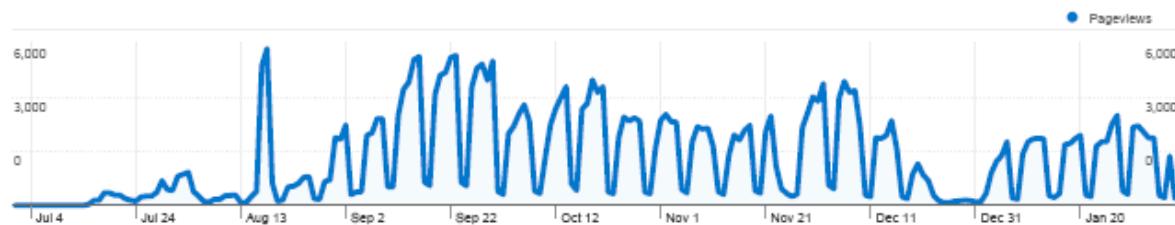
**Figure 1: Battleship Numberline in Ship mode where players type in a fraction to estimate the ship's position on the numberline.**

In *BSNL*, players make estimates about the location of “enemy” ships or submarines by deducing their locations on a number line. There are two main modes: Ship mode and Submarine mode. In Ship mode, players type a number to estimate the position of the ship on a number line. In Submarine mode, players are presented with a number that indicates the location of a hidden submarine, and the player needs to click on the location of the number line that they believe corresponds to the number. While *BSNL* offers number line practice in several domains—whole numbers, domains, fractions, and units of measurement—in this paper, we focus on experiments conducted with players accessing the fractions level of *BSNL*.

### Experiments

By teaming up with BrainPOP and their new GameUp web portal ([www.brainpop.com/games](http://www.brainpop.com/games)), we have been able to collect data from over 1,000 players per day. BrainPOP, founded in 1999, creates animated, curriculum-based content that engages students, supports educators, and bolsters achievement. The GameUp portal, a free resource that showcases top online educational game titles

and offers materials to facilitate the effective use of games in the classroom, currently features over four dozen games and has attracted an average of 1.3 million unique pageviews/month during the school year. *BSNL* was originally linked into the GameUp portal in July 2011 and we have been collecting data since that time. Figure 2 shows the distribution of 377,772 page views for *BSNL* that were collected via the portal from July 2011 until the end of January 2012. While large-scale online experiments have been done on game portals such as Kongregate (Andersen, Liu, Snider, Szeto, & Popović, 2011), using a game portal that is popular in schools produces a different type of experimental population: students using mini-games in a classroom setting. This graph clearly shows the cyclical nature of students accessing the game during the school week with lulls every weekend represented by the dips in the graph. Also, we note the big jump that occurred on August 13th when *BSNL* was the featured game on the GameUp site and the huge drop off over the holiday break in December 2011.



**Figure 2: Page View data of *BSNL* from BrainPOP for July 2011 through January 2012**

In Figure 3, the 51,140 page views for January 2012 are show in more detail. Although we have limited data on who is actually playing the game, the graph clearly shows the drop off each weekend which again bolsters the claim that most of the game use is taking place during the school day. Looking a bit deeper into the log data we see that these page views translate into almost 100,000 rounds of the game played and 986,089 individual problem attempts. Collecting this amount of data from the classroom in a single month using a traditional experimental design would have been impossible.



**Figure 3: *BSNL* page views over January 2012.**

### Game Design “Super Experiments”

Our activities are informed by the Super Experiment Framework, which involves conducting experiments at various scales—Internet, lab, and school—with each component providing findings that may be used to answer specific questions that might have been difficult or impossible to answer using one of the other scales (Stamper, Lomas, Ching, Ritter, Koedinger, & Steinhart, 2012). Various components can be used to expand or validate findings of the other components. For example, Internet-scale experiments can identify areas of focus for lab-scale experiments, which can then be validated in school-scale experiments.

While a traditional classroom or laboratory experiment may involve dozens or even hundreds of subjects, online game research can involve thousands or even hundreds of thousands of subjects. This increased scale creates the opportunity to design a large number of experimental conditions. Large factorial design experiments offer a simple and straightforward mechanism for producing useful experiments. Rather than randomly assigning players to a specific experimental condition, as is the norm for quantitative research studies, we simply randomize the presentation of various design factors. Given that a design factor has been randomly assigned to players, we are able to statistically infer the effect of this factor on player engagement and learning. In order to systematically measure learning and engagement, we implement various design factors as flexible XML-based parameters

that can be determined at game runtime. An intuitive editor allows us to create specific instructional units by modifying XML game parameters, which include end points, time limit, percent accuracy required for success, items to be tested, and the order (randomized or non-randomized) in which these items will be presented (Figure 4). Overall, the level builder allows for the creation of specifically tailored intervention units.

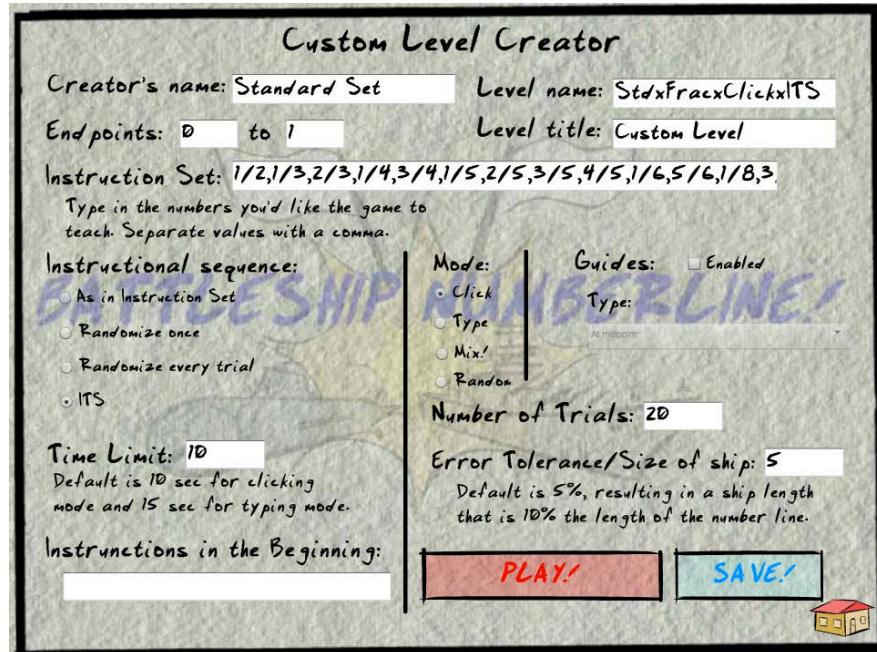


Figure 4: XML Level Editor for BSNL

## Analysis of Experiments

From March 26, 2012 to April 26, 2012, we conducted an online experiment on GameUp involving 6 different design factors, each with 2-10 different factor levels. This resulted in 121,500 unique experimental conditions. However, because we were primarily interested in the 2- and 3-way interactions between the different design factors, ~50,000 game players (as subjects) were more than sufficient for analysis.

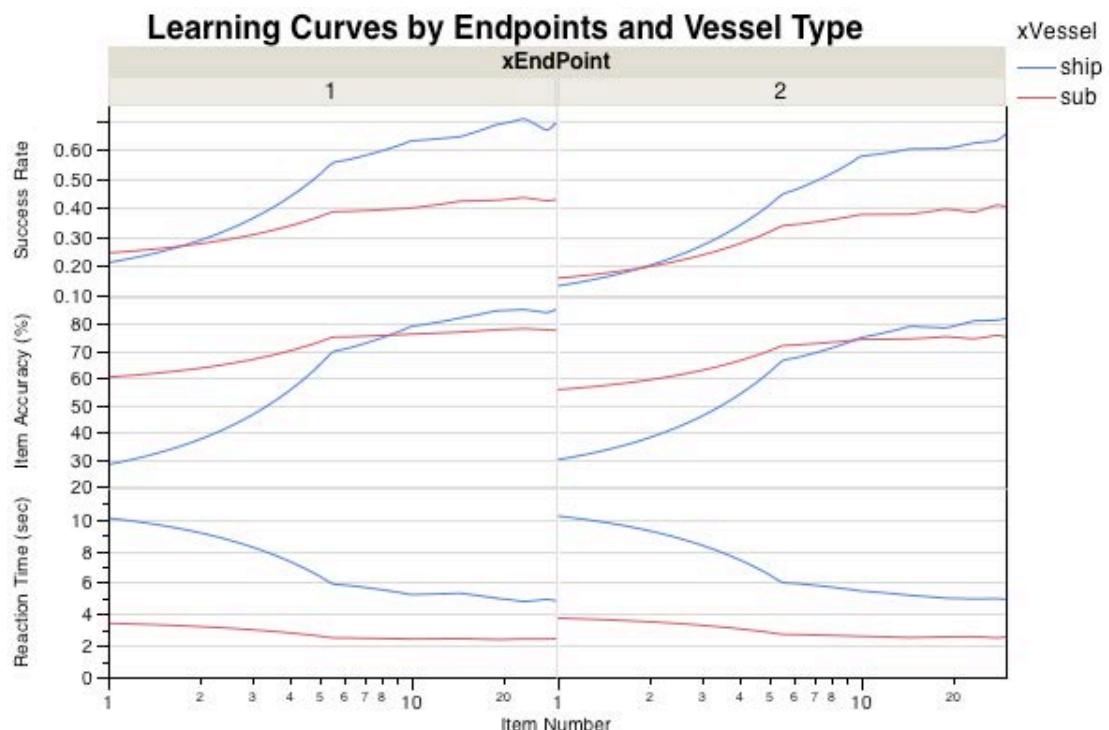
Design Factor	Number of Factor Levels	Example Factor Level	Description
Game Mode:	2	Ship	Ship mode (typing a number to correspond to the visible position of the ship) or Submarine mode (clicking on the line to estimate the location of a hidden submarine, in response to a number presented)
Endpoints:	3	0-1	The numbers displayed on the endpoint flags in figure 1
Item set:	10	3/8, 3/7, 4/5, 2/5, 3/10, 7/8, 1/6, 9/10, 7/10, 1/5, 1/3, 1/8, 1/2, 5/8, 5/6, 1/10, 3/4, 3/5, 2/3, 1/4	The numbers (or locations, in ship mode) presented in each level. Can be in fraction, decimal or whole number form.
Time limit:	9	10	The number of seconds permitted before time runs out.
Error Tolerance:	9	5%	This determines the size of the ship, where a 5% error tolerance makes the ship 10% of the line. A bigger ship is easier to hit with an inaccurate estimate.
Tickmarks:	5	none	Tick marks can be shown at the midpoint

			or at 3rds, 4ths, 5ths, 10ths of the line.
<b>Item Sequencing:</b>	5	Random without replacement	This includes random order, ordered as listed, or a series of different adaptive sequencing algorithms, such as Bayesian Knowledge Tracing (Lomas et al 2012)

**Table 3: Design factors deployed in the March 26, 2012 super experiment**

A primary goal of our research has been to elucidate the underlying factors behind creating effective educational games that are intrinsically motivating to play. We are currently using three metrics to measure in-game learning: changes in embedded pre-test to post-test scores, changes in early-game to late-game performance, and the learning curve documented by performance over opportunities to demonstrate mastery of a certain schema or knowledge component (Baker, Habgood, Ainsworth, & Corbett, 2007). We operationally define player engagement primarily in terms of the amount of time spent playing a game, final level achieved, and the number of items attempted (Lomas & Harpstead, 2012).

During gameplay, *BSNL* log file data system records player performance (reaction time, success rate and percent absolute error, defined as the absolute value of the actual location of the ship minus the player's estimated location, divided by the length of the number line) at each opportunity against the game's pre-specified task characteristics. With either of these performance measures, we can then plot learning curves over the course of play. Learning curves are typically logarithmic, where early practice opportunities produce much more improvement than subsequent practice opportunities.



**Figure 5: Learning curves for ship mode (where players are given a location and type a corresponding fraction) versus sub mode (where players are given a fraction and click a corresponding location). Endpoint 1 is from 0-1 while endpoint 2 is from 0-2. Data was collected as part of the March 26, 2012 super experiment; the above data included only players in the fraction domain who played over 30 items in total.**

Many small experiments take place within a single super experiment. For instance, we can investigate the main effects of error tolerance on player engagement. Error tolerance within *BSNL* refers to the size of the ship on the number line. In Figure 5, the ship has an error tolerance of 5%, where any estimate that is within 5% will register as a "perfect hit" (as opposed to a "partial hit" or "miss). A bigger ship has a bigger error tolerance, and is therefore easier to hit with an inaccurate

estimate. In the March 26 super experiment, we randomized the size of the ship at 9 different levels (2%, 3%, 4%, 5%, 8%, 10%, 12%, 15%, and 20%). At 20% error tolerance, the ship was very large: almost 40% of the number line! While making the game easier has a significant effect on engagement (length of play), the effect diminishes and even eventually appears to reverse. This results in an inverted U-shaped curve reflects dominant theories of game enjoyment (Koster, 2005), which hold that players prefer a balanced challenge.

## Implications for Design

A simple heuristic can guide game designers who wish to measure learning within a game: repeat and randomize. Repetition of items or levels allows for a within subject comparison over multiple opportunities. Randomization allows for a between subject comparison, where analysts can consider whether the randomized design factor had a significant effect on learning (in comparison between subjects that received a given design factor level and those that did not). Regardless of one's understanding of statistics, game designers can typically produce games that allow for learning measurement if they remember: "Repeat and Randomize."

Games can generate enormous amounts of data. Rather than collecting data at every change in state of the game, learning game designers may find it useful to limit data collection to each opportunity to succeed or fail at a challenge presented.

## Conclusions and Future Work

Our findings to date demonstrate that significant differences in player performance, learning, and engagement occur due to differing game configurations. This strongly suggests that we can systematically improve the quality of our games based on user-generated data. Technology has presented us with new options for deploying and collecting massive amounts of data using the Internet and popular game portals such as BrainPOP's GameUp. The main contribution of this paper is to show how, with proper design, educational games can be deployed at Internet scale to collect abundant amounts of data addressing multiple experiments in a very short amount of time.

The primary limitation of this internet-scale research is the ambiguity of the user base since the experiments are conducted anonymously. To address this problem we are currently conducting lab and controlled classroom experiments in conjunction with the web based experiments in order to test how well the online experiments correlate with lab experiments and controlled classroom experiments. We plan to report our activities at the various scales, as they pertain to the goal of identifying and accumulating empirical evidence for fractions estimation learning in *BSNL*.

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# Civic Beyond Play: Ties to Public Life for Small-Group Gamers

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**Abstract:** Commercial games are rarely studied for their links to traditional civic engagement. This study examined thousands of players of a popular team-based game, and investigated ties to offline volunteering and protest. Contrary to stereotypes, this study reveals civic participation rates of gamers comparable to a normative stalwart: the typical American parent. Small-group gamers had unusually high rates of “peaceful protest, march, or demonstration”—more than twice the lifetime rate of American parents. Several predictive models for protest were compared, using game-based indicators to confirm these civic models across the game boundary. Protest was best predicted by theories of political engagement (such as being liberal and awareness of key advocacy groups), rather than socio-demographics (such as income and gender). Several game-related behaviors were especially useful in the model, including whether a player had recruited others to join the game; conversely, high hours spent gaming did not undermine the likelihood of protest.

## Overview

Despite stereotypes that games lack altruism, 76 percent of American teens report helping others while gaming (Kahne, Middaugh, & Evans, 2008). This may have implications for civic culture more broadly, given the rise of mainstream gaming. Can the civic life of mainstream gamers be understood in terms of their voluntary play?

This study examined thousands of participants in a popular commercial game. To parallel the bowling leagues discussed by Putnam in his classic analysis of civic decline (2000), this study focused on a game *without* any particular altruistic message, but with small-group play that is competitive and social. Looking across the “magic circle” of games (Huizinga, 1938), this study investigates the social values and motivations that might persist and cultivate civic behavior.

## Civic Life in Transition, as Games become “Third Places”

Civic participation contributes to a host of desirable social outcomes, including better economies, less crime, better schools, and greater trust in government (Putnam, 2000). Yet this picture is not static—society and our very definitions of civic participation continue to evolve, for better and worse. Protest has been on the rise in American society, for example, as possibly the first civic act to begin decoupling from traditional politics (Earl & Kimport, 2009). Meanwhile, youth membership in more traditional voluntary associations has declined 18-25% since the 1970s (General Social Survey; in Levine, 2007, p. 82).

Simultaneously, videogames have emerged as a mainstream medium and social context, with more than 70 percent of American households playing (Entertainment Software Association, 2010). Commercial games are increasingly recognized as authentic and meaningful domains of human activity in their own right. For example, some games have real economies that follow macroeconomic laws (Castranova et al., 2009). Others have content and social dynamics that are complex enough to constitute separate “third places” to build social capital (Steinkuehler & Williams, 2006), and may even be meaningful spaces for direct civic action (Thomas & Brown, 2009).

Since most commercial games are not designed for civics, and there is a movement to create entirely new “games for change.” This alternative agenda for games has been growing in policy and funding circles (see, for example, <http://gamesforchange.org>), but their distribution is often relatively limited (Bers, 2010; Raphael, Bachen, Lynn, Baldwin-Philippi, & McKee, 2009). If there is civic potential in existing mainstream games, the scale of impact could be considerable.

### **Small Group Focus (in Popular Games and Civics)**

Since commercial games are rarely civic in their content, their effect has more potential through the shaping of social networks and relationships. This parallels research into traditional civic determinants, which often de-emphasize formal contexts. For example, longitudinal studies of volunteering have found that being knowledgeable about civics does not lead to increased participation, but that being a member of extracurricular groups is predictive of subsequent voting and volunteering (Hart, Donnelly, Youniss, & Atkins, 2007). This was especially true when there is helping behavior or civic content in the background, which may parallel the helping behavior in small-group games.

Small-group games are under-studied, compared to the immersive 3D universe of virtual worlds and massively multiplayer games. Small-group is increasingly popular online, with millions of daily players (Rose, 2011). While small groups can exist within more massive games, the overall experience may be more akin to a game of pickup sport that may lead to ongoing ties, rather than the sustained bowling leagues that have received so much civic discussion (as per Putnam's *Bowling Alone*, 2000).

In small groups, participants come into repeated contact with a small number of people, building the critical connections necessary for future action, including political recruitment, conversations on political news, and dissemination of new online tools for civic action. Fine and Harrington describe small groups as "the crucible in which civil society is created and enacted" (2004, p. 344). Yet little work has compared the players of small-group games to stereotypical upstanding groups, such as parents.

Parents are a useful positive comparison group for a number of reasons. Parents are at an age when political activity like voting is higher than for youth or for the elderly; and when their life patterns have settled into adult roles as they "build up their stake in community affairs" (Flanagan & Levine, 2010, p. 160). Furthermore, parents can be particularly pulled into civic life by their family; for example, parents may become active through their child's school and become more attuned to policies that affect their child (Rotolo, 2000). As a group, parents tend to volunteer at least 5% more than the overall U.S. population (for example, 33.6% in 2010 compared to 26.3% in the population (Corporation for National and Community Service, 2011)). Especially when *lifetime* participation rates are considered, parents can be a proxy for good citizens.

*RQ: For small-group gamers, are lifetime civic participation rates comparable to those of American parents, a stereotypical "good citizen" group?*

### **Protest and Civic Recruitment**

If gamers are civically active, which game behaviors are tied to their civic participation? Protest is a civic behavior deserving particular attention. Protest is at the foreground of shifts in national civic trends away from traditional political engagement, partly because protest has grown so fast (Earl & Kimport, 2009). Games may have particular importance to the civic act of protest by helping players to develop tolerance for confrontation and what Stephen Duncombe calls "ethical spectacle" (2007).

The causes of protest are theorized in terms of three competing models of recruitment (Schussman & Soule, 2005). They include: (a) biographical availability, (b) political engagement, and (c) structural availability. These have not been investigated for commercial gamers. Biographical availability is defined as the "absence of personal constraints that may increase the costs and risks of movement participation" (McAdam 1986, in Schussman & Soule, 2005). Perhaps the most basic indicators are socio-economic: income, education, age, gender, and race. Such socio-economic controls are historically important for equity issues in social justice.

As part of biographical availability, this study will also consider the raw number of hours spent playing games. The controversy over whether play reduces civic activity is a matter of public contention (e.g., National Institute on Media and the Family, 2008). One prior study found no strong relationship between gaming time and civic engagement (Kahne et al., 2008). Yet that study was forced to lump together small-group and single-player games, and to collapse various civic acts into one measure, whereas civic scholars have long understood that different acts have relatively distinct causal chains. Moreover, time might only be a factor beyond a threshold tipping point—an argument prominently articulated by McGonigal who has claimed that "moderate gaming" of 21 hours a week is healthy (2011).

Biographical availability can also be extended to personality traits, which can constrain an individual's odds of protesting. Mild trait effects on civic behavior have been demonstrated (Mondak, Hibbing, Canache, Seligson, & Anderson, 2010; Opp & Brandstätter, 2010). For example, volunteers disproportionately express cooperation over individualist or competitive values (Bekkers, 2007). In games, role-playing has the potential to manifest traits, especially where the choosing of avatars forces a choice between competing social values. Some avatars emphasize helping behaviors; others are attacking characters or stealthy messengers.

*H1: players who prioritize cooperative values around their gameplay will also manifest in higher rates of traditional offline protest.*

The second model for protest--political engagement--can be approached in terms of both political interest and political information (Verba, Schlozman, & Brady, 1995). For gamers, this might particularly manifest in games-based policy engagement, such as "gamer rights" campaigns to limit the censorship of games. Political engagement is also affected by being political liberal, since protest is often seen as a particular tool for progressives to make their voices heard (Dalton, 2002 in Schussman & Soule, 2005).

*H2: The odds of protesting will be higher for gamers who show political engagement (such as staying informed about gamer rights), and who are politically liberal.*

Finally, the third model for protest concerns interpersonal networks. The availability of such networks to any individual is often called structural availability. These networks can be described in terms of the social capital of the individual; greater social capital is associated with greater civic participation overall, and for Putnam its decline is one of the best explanations for diminished political participation (2000). For games, theoretical and empirical work has increasingly established that social networks also make sense and can connect offline (e.g., Steinkuehler & Williams, 2006). Teaming up with offline friends is one way to bridge the magic circle of games, including with romantic relationships. Overall, combining this model with the political engagement model is expected to perform better in predicting rates of protest than the engagement model on its own.

*H3: Greater rates of protest are expected for gamers with more social capital, including co-play, and for those who have experience with recruiting others to play the game.*

## **Method**

In this study, data were collected anonymously on players of League of Legends (LoL), a game featuring small teams of 3-5 players that was released in October of 2009. LoL had at least ten thousand players daily at the time of the survey (e.g., as based on the gaming tool Xfire, 2010); more recent estimates suggest it is one of the most popular online games, with more than 1.4 million daily active players (Rose, 2011). The game is played in live action matches, where each team seeks to capture their opponents' base, and a winner is typically determined within 20-60 minutes.

The game operator, Riot Games, facilitated the distribution of a survey to a large sample of players and also provided server-side data from the game's back-end databases. The former offered psychological and demographic information, while the latter offered behavioral logs of the player's actions, interactions, and successes or failures.

Participants were randomly selected players of LoL who had been active in the game over the two months prior to the survey. During the one-week window, we collected 22,091 complete responses with a response rate of 85.0%. In order to exclude those players who clicked through the survey to simply get the incentive of an in-game boost, we removed all cases which finished the survey less than 12 minutes. Additionally, we excluded cases in which participants gave inconsistent responses to similar positively and negatively worded items. Only American players were retained to improve coherence, since civic life varies significantly by country. After these cases were removed, 9,392 cases were included in the final analysis. The participants were predominantly male (96%), with an average age of 21.9 years ( $sd=5.0$ ), had a somewhat larger household income ( $mean=\$55,000-\$60,000/year$ ) and more education than the general American population (for a detailed description of player demographics across games in comparison with the general U.S. population, see Williams, Yee, & Caplan, 2008). All player data were recorded anonymously.

For the research question seeking comparison with American parents, the number of cases was reduced to improve comparability. Specifically, the LoL dataset was restricted to age 30 or older, since the vast majority of PEW parents were over 30; to further improve the comparison with parents, LoL respondents were only selected who were either co/head of household, parent of head of household, resulting in 639 valid LoL survey respondents and more than 1000 PEW parents. Similarly, since parents with children have less time available (for a brief discussion see Schussman & Soule, 2005), the civic questions only compared *lifetime* aggregates of civic participation rates for gamers and parents.

Civic participation is typically measured using indicators for very diverse activities, from volunteering, to voting, to staying informed about current events (Levine, 2007). For this study, five behaviors were selected—the same set used in the first nationally representative survey to examine civic behavior in teen game play (Kahne et al., 2008). Mimicking this prior study, each civic behavior was measured by asking whether the respondent had engaged in that activity (yes; yes, but not in the past 12 months; never); activities included: having volunteered; raised money for a charitable cause; taken part in a peaceful protest, march or demonstration; stay informed on current events and politics; and convincing people to vote in some manner in an election.

For the social value orientation (as part of predicting protest), a scale was developed for the “orientation to help.” This scale identifies whether players made helping choices in two contexts. First, in the pre-match portion of the game, players are encouraged to choose roles by selecting an avatar, each of which has different strengths and weaknesses. Second, during the game, players can choose to be more or less helping (e.g., a preference for healing spells), and paying particular attention to teammates’ health. The combined scale of four items had a Cronbach’s alpha was 0.755, indicating reasonable consistency.

Social capital was considered in game terms as co-play with relatives or significant others, and for more traditional bonding capital using the Internet Social Capital Scales (Williams, 2006). The co-play measure was a binary variable calculated using three survey items (one for romantic partners, one for offline friends, and one for relatives); if the player “often” or “always” played with any such offline connection, then co-play capital was coded as true.

## Results

In comparing the rates of civic participation for small-group gamers with American parents, no statistical difference between participation rates was found for two behaviors: charitable donation and volunteerism (see *Table 1* for t-tests of independent samples). Gamers actually had higher rates of participation for peaceful protest, and for staying informed on civic and political events ( $p<.001$ , and  $p<.01$ , respectively).

The protest difference is especially noteworthy: more than twice as many gamers reported having ever protested, compared to American parents (25.7% versus 10.4%). The size of this gap was a surprise, and redoubles the importance of more closely modeling protest behavior for gamers below.

	Gamers (ever done this)	Parents (ever done this)	Mean Difference	T	df	Sig. (2- tailed)	Std. Error Diff
<i>Stayed Informed</i>	88.7%	83.9%	<b>4.8%</b>	2.884	1538	.004	.01662
<i>Donated</i>	74.3%	76.0%	-1.7%	-.788	1357	.431	.02137
<i>Volunteered</i>	68.0%	71.1%	-3.1%	-1.354	1360	.176	.02272
<i>Advocated</i>	53.6%	N/A	N/A	N/A	N/A	N/A	N/A
<i>Protested</i>	25.7%	10.4%	<b>15.3%</b>	7.885	1044	.000	.01938

**Table 1: Comparing civic participation rates for small-group gamers to American parents using an independent samples t-test**

Three models for protest were then compared using a binary logistic regression (see *Table 2* for estimates of the parameters). As hypothesized, the model for biographic availability had a relatively minor role in the overall regression. Most socio-demographic factors were non-significant or barely significant in light of the large sample size ( $n=4337$ ); these included gender and log-income. Against

expectations, age was barely significant, though its negative sign is in the expected direction. While educational attainment and being a student were initially significant, their role diminished when political engagement variables were included. This implies that the effect of educational attainment is better explained in terms of overall political activity.

When the model is expanded to include game-related elements of biographical availability, it improved. Most importantly, the presence of a helping social value orientation within the game was highly significant ( $p < .001$ ), controlling for other factors across all models. In other words, a player's approach to avatar choice and team play correlated with their rate of protest. The size of this effect, according to the model, is a 4.9% greater likelihood of protest for those who also made more helping choices in the game, compared to those who made fewer (specifically, this is the predicted difference in protest rates between those whose "orientation to help" is one sigma above the mean, and those one sigma below). This supports the hypothesis on the role of game-based social value orientation. The amount of hours spent playing games was not significant.

Independent Variables	Model 2		Model 3		Model 4	
	$\beta$	exp( $\beta$ )	$\beta$	exp( $\beta$ )	$\beta$	exp( $\beta$ )
<b>Biographical Availability (non-game)</b>						
Gender (female)	.189	1.208	.171	1.187	.191	1.211
Education	.104 ***	1.110	.070 *	1.072	.074 *	1.077
Student	.205 *	1.228	.128	1.137	.121	1.129
Income	-.002	.998	-.005	.995	-.004	.996
Age (log)	-.490	.613	-.568 *	.567	-.595 *	.551
<b>Biographical Availability (game)</b>						
Altruistic values within LoL	.216 ***	1.241	.150 ***	1.162	.138 **	1.147
Time moderation for play	-.128	.879	-.089	.915	-.122	.885
<b>Political Engagement</b>						
Recent Civic Activity (volunteered)			.475 ***	1.607	.469 ***	1.599
Recent Civic Activity (donated)			.336 ***	1.400	.333 ***	1.395
Recent Civic Activity (advocated)			.762 ***	2.143	.751 ***	2.120
Stays informed recently			.074	1.077	.084	1.087
Registered to Vote			.426 ***	1.532	.431 ***	1.539
Liberal Ideology			.229 ***	1.257	.229 ***	1.257
Aware of the Game Voters Network			.467 ***	1.595	.453 ***	1.573
Wants games regulated separately			.094 **	1.098	.091 **	1.095
<b>Structural Availability</b>						
Social capital via co-play					-.032	.969
Bonding social capital					-.005	.995
Recruitment of other Players (skill)					.051 ***	1.052
Constant	.138	1.148	-.543	.581	-.356	.700
Chi-square	62		499		515	
df	7		15		18	
BIC	-2		-372		-363	

**Table 2: Estimates (log-odds and odds) from selected logistic regression models of players' protest incidence (=1, 0 otherwise); (N = 4337; \*= $p < .05$ ; \*\*= $p < .01$ ; \*\*\*= $p < .001$ )**

The next model in the regression considered the theory of political engagement; it was the BIC-best model (an indicator of parsimony). The hypothesis that political information is needed had mixed support. Awareness of advocacy organizations for gamer rights had a large effect: the model predicts a 9% increase in protest rates when an individual is aware of the gamer advocacy organization, controlling for other factors. Yet general political news about gamer issues was not significant factor.

Protest was best explained in the engagement model by participation in other civic acts, especially recent advocacy (odds of protest go up 13% if there was recent advocacy). Voter registration was also significant and roughly comparable in effect size. Expressing more liberal political views had the predicted effect of increasing the odds of protest. The effect size was considerable: according to the

model, there is a 13% greater likelihood of protest for those one sigma above/below the mean. However, when the model was expanded to include factors of structural availability, it was not BIC-better. Social capital via co-play (where players frequently play with a romantic partner or family member) was not significant, nor was bonding social capital. Importantly, those who expressed the civic skill of recruitment in the game (in terms of the number of people they had recruited to play) were significantly more likely to also participate in protest, controlling for other factors. In this way, game-specific social capital indicators seem to have explanatory power separate from traditional social capital measures.

## Discussion

This study sought to understand how civic life for small-group gamers is tied to their behavior inside the game. Protest rates were of particular interest, given the rise in protest globally, and the possibility that the role-play of games might cultivate or require a kind of tolerance that is also needed to protest. A large sample of participants ( $n=8,234$  Americans adults; from a total of 18,629 valid cases) was drawn from League of Legends (LoL), a popular commercial videogame that features small group play in differentiated roles, including helping roles.

One goal of this study was to explore the stereotype of the civically-disengaged gamer. Comparisons were made between a subset of older LoL players and American parents. Similar rates of participation were found compared to typical American parents for volunteering, charitable giving, and staying informed about political issues. The rate of protest was significantly higher for game players—approximately double the lifetime rate of parents who had ever protested. This unusually high protest rate might be explained by the possibility that LoL players find protest less intimidating than typical Americans—a promising area for future research. Protest is often filled with spectacle and can be confrontational (Duncombe, 2007), but if gamers have a special disposition to protest, it is still unclear whether that is a shared bias across both activities, or if one somehow causes the other.

Three models for protest were investigated, including several indicators drawn from game-specific behaviors. The BIC-best model included the theories of biographical availability and political engagement, but not structural availability. The lack of additional contribution from structural availability may itself be noteworthy, since it implies that social capital adds little explanatory power once we control for individuals' ongoing political engagement. For the political engagement model, particular attention is due to the performance of game-related measures, specifically to awareness of gamer policy groups, in contrast to the lack of contribution from more general political news. This contrast underscores the importance of understanding the civic lives of gamers using indicators that are proximal to their passion for games.

The orientation to help inside the game was significant in predicting the odds of protest, accounting for a 13% likelihood increase, controlling for other factors. This further supports the search for measures that permeate the game and civic worlds, and suggests some value in future use of our scale for the “orientation to help” inside role-playing games. Future work on role-play and civics should deepen the relation to social value orientation theory, and investigate how it varies depending on the civic act.

Research is only beginning to investigate how gaming behaviors connect to everyday civic life. This study was cross-sectional, and so cannot make causal claims. It does argue for the particular importance of small-group games, distinguished both by their social dynamics and by the frequent role-play that supports helping behavior. Additional research is needed to explore how sustained participation in games might have causal effects. For example, does sustained play deepen the orientation to help in the game, or undermine it—and do such shifts also lead to greater civic inclinations outside the game? Given the dozens of hours per week that many players dedicate to LoL, a more systematic investigation is warranted.

Future work may also inform the more deliberate design of role-play for civic goals, especially since role-based training is already widely used for behavior change (Taylor, Russ-Eft, & Chan, 2005). Games like LoL may parallel bowling leagues, which have strong civic implications despite the lack of explicit civic framing. As videogames become increasingly capable of supporting human social activity, it seems only natural that civic dispositions will develop inside of game-based environments, and spread well beyond.

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# Applying Motivation Theories to the Design of Educational Technology

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**Abstract:** Although there has been a wealth of research exploring motivation within technological environments, few of these studies employ frameworks that are grounded in well-established theories of motivation. This paper brings rigorous theoretical frameworks of motivation to the study and design of educational technology. First, we outline key motivation constructs that compose Eccles and Wigfield's Expectancy-Value theory and the Self-Determination theory and discuss their implications for education. Through a case study, we then illustrate how motivational theories informed the recent development of a virtual learning environment designed to promote students' interest in and motivation to pursue science, technology, engineering, and mathematics careers. Finally, looking toward the future of mobile learning, we discuss the motivational affordances of personal and portable features of mobile handhelds.

Though much effort has been put toward integrating game elements in educational spaces to improve learning, results have been disappointing (Hogle, 1996; Kerawalla & Crook, 2005). One reason for this unsuccessful hybrid is that designers have taken a "chocolate-covered broccoli" (Bruckman, 1999) approach in which the gaming element is a reward for completing the educational component. Educational games need to be designed in a way that allows for the learning material to be delivered through the parts of the game that are most motivating (Habgood, Ainsworth, & Benford, 2005). The purpose of this paper is to bring rigorous theoretical frameworks of motivation to the study and design of technology-based learning environments. Although there has been a wealth of research exploring motivation within technological environments, few of these studies employ frameworks that are grounded in well-established theories of motivation (Moos & Marroquin, 2010). In this paper, we first introduce two theories of motivation that can be applied to the design of educational technology. Second, we illustrate how motivational theories informed the development of a virtual learning environment designed to promote students' interest in and motivation to pursue science, technology, engineering, and mathematics careers. Third, we look toward the future of mobile learning and discuss the motivational affordances of personal and portable features of mobile handhelds.

Increasing student motivation is a prime target for improving education because what people believe is quite often a better predictor of actual performance than is previous achievement or even actual capability (Bandura, 1997). In this light, it is quite disheartening for teachers, for example, to see a student who exhibits great potential, but because of self-doubt or lack of interest in a subject, does not perform on par with what that student should be able to do. Some scholars argue that motivational factors play a larger role than academic performance in predicting continued learning. For instance, in an introductory undergraduate psychology course during freshman year, motivation was more predictive of subsequent course taking and majoring in psychology over a 7-year span than were grades from that introductory course (Harackiewicz et al., 2002). Similar patterns have been found for middle school and high school students (Hidi & Harackiewicz, 2000; Hidi, 1990; Hidi & Renninger, 2006; Harackiewicz et al., 2002). Though research on motivational theories and their applications to education has generated thousands of journal articles, there is relatively little empirical evidence about whether these theories also hold up in educational technology settings.

## Motivation Theories

We highlight two theories of motivation that offer researchers, educators, and designers useful and theoretically grounded constructs that can be empirically studied in educational contexts. By motivation, we are referring to the "the process whereby goal-directed activity is instigated and sustained" (Pintrich & Schunk, 2002, p. 5). Both the Expectancy-Value theory and Self-Determination theory highlight what influences this goal-oriented process.

### **Expectancy-Value Theory**

One widely used theory of motivation in education research is Eccles and Wigfield's Expectancy-Value theory (e.g., Eccles, 1987, 1993; Eccles, Adler, et al., 1983; Eccles, Wigfield, et al., 1989; Wigfield, 1994; Wigfield & Eccles, 1992, 2000). This theory provides a useful framework for understanding students' beliefs about how competent they are and what they value within the context of their academic studies. Students are motivated toward or away from particular activities by answering the question, "can I do this?" This question lies at the heart of the *expectancy* component of theory. Furthermore, to be motivated to do something, students must not only believe that they have the competence to do it, but they also need to see the *value* of doing it. For instance, students can easily decide that they are highly capable at succeeding in math; but, if they do not see the point of becoming proficient, there is no reason for them to exert the necessary effort to succeed. Task values are defined by four components: the perceived importance of the task based on it being enjoyable and fun to engage in (interest), influential to the individual's identity (attainment), useful in the individual's life (utility), and having perceived negative aspects of engaging in the activity, such as negative emotional states (cost). Studies have indicated that task values (particularly interest and utility) are associated with course enrollment decisions, free-time activities, and intentions (Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002). The expectancy-value framework of motivation posits that individuals will be motivated to engage in a task to the extent that they feel they can be successful at it and to the extent they perceive the task as being important to them.

### **Self-Determination Theory**

The Self-Determination Theory suggests that motivation arises from the needs for competence, autonomy, and relatedness being met (Deci & Ryan, 2000). That is, to be motivated, people need to feel that they are the following: (1) capable of understanding the material; (2) in control of their environment; and (3) socially connected in the process. Research shows that these three needs contribute to inherently enjoyable activities that are therefore intrinsically motivating. Compared with those pursuing an activity for external rewards such as money or grades, intrinsically motivated individuals are more creative, enjoy the activity more, and process information more carefully and completely (Ryan & Deci, 2000). Our premise is that by using technology to address the psychological needs of competence, autonomy, and relatedness, we can foster sustained engagement and positive learning outcomes.

### **Application of Expectancy-Value Theory to a Virtual Environment**

An NSF-funded project at Harvard's Graduate School of Education, entitled *Transforming the Engagement of Students in Learning Algebra* (TESLA), illustrates how motivation theories can be incorporated into instructional technologies. For this project the researchers created a 4-day mathematics intervention, two days of which involve one of several technology-based motivational inductions for students in Grades 5-8 before classroom instruction. In this paper, we highlight one condition in which the game-like activity introduces students to math concepts through their avatars' active involvement in an event. In designing an environment that is motivationally sound, we removed elements of commercial games that either undermine or distract from the learning and motivational goals (e.g., competition, time-sensitive pressures, and overt performance goals).



**Figure 1:** Opening screen: Space rescue mission

Students solve a total of five puzzles in the game, recognizing mathematical patterns in the context of a space rescue mission (see Figure 1). The first puzzle allows students to become accustomed to how to function and interact in the virtual world. As such, the mathematical puzzle is relatively easy so that students can familiarize themselves with the controls as well as experience early success to build their self-efficacy for solving these types of problems. Self-efficacy, defined as one's confidence in accomplishing a particular task, is closely associated with the expectancy construct of the Expectancy-Value theory (Bandura, 1997). This first puzzle is similar to a combination-lock problem in that students must identify all possible ways that three numbers can be combined to produce a unique 3-digit number (see Figure 2). When students finish, they proceed to a more complex and difficult second puzzle. This puzzle is broken down into smaller steps to scaffold students' learning and thereby increase their self-efficacy to solve a complex problem. If students were given the entire puzzle all at once, many could be overwhelmed and quickly become discouraged.



**Figure 2:** First puzzle: Combination-lock problem

For the second puzzle, students encounter a door that is locked. Next to the door is a box with complex circuitry. Parts of this circuit board are complete, but the great majority of it is broken.

Students must “fix” each section of the circuit board by building circuits with 1- and 2-unit length fuses. The circuits that must be constructed differ in size—at first, students build a 1-unit long circuit (only one possible combination if presented with only 1- and 2-unit long fuses). Then they build circuits that are 2-unit long (2 possibilities: 1+1 and 2), 3-unit long (3 possibilities: 1+1+1; 2+1; and 1+2), and so forth, until they reach a circuit that is 9-unit in length (55 possible combinations) (see Figure 3). What emerges from this activity is the fact that a Fibonacci series, in which each subsequent number of possible combinations is the sum of the previous two, underlies the pattern (1, 2, 3, 5, 8, 13, 21, 34, 55). Because students are not explicitly taught the Fibonacci series in school, most students are likely to enter this activity unaware of this pattern. However, due to its simplicity, the activity is well within students’ cognitive abilities.

We designed this activity with many cognitive scaffolds in the beginning that are progressively removed so that students can develop a belief that they are able to solve this type of problem (i.e., expectancy). For example, students start out by building actual circuits that are 1-unit, 2-unit, and 3-unit in length using only 1-unit and 2-unit long fuses before tackling longer circuits that require pattern recognition. Through these mastery experiences, students’ perceived past successes lead them to become more confident in being able to accomplish similar tasks. According to Bandura (1997), mastery experiences are the most powerful source of self-efficacy, which makes it an attractive way to build expectancy for success in this virtual environment.



**Figure 3: Second puzzle: Fibonacci circuit problem**

When students reach circuits that are 4- and 5-unit long, the number of circuits that can be built at each height increases dramatically. Building each individual circuit becomes not only more difficult, but also more tedious. Therefore, students are shown all the different combinations that can be built at 3-unit high (e.g., 1+1+1; 2+1; and 1+2 for a total of 3 circuits) and 4-unit high. From this information, they must make an educated guess as to how many circuits can be made, using 1- and 2-unit length fuses, when the circuit is 5-unit in length. Students are no longer building this circuit from scratch (removing a scaffold) but are instead deducing patterns. If they guess incorrectly, feedback is provided to students so that they can begin to build the individual circuits in a systematic and orderly fashion.

As students progress through this step to more complicated circuits (6-, 7-, 8-, and 9-unit high), more scaffolds are removed so that students are progressively given more autonomy and responsibility for providing the correct response. Again, appropriate feedback is provided every time a student does not generate the correct response. At the end (for the 9-unit long circuit that requires 55 unique combinations), the environment is constructed so that students are not given the opportunity to build the circuits if their initial estimate is incorrect. Rather, students are given a visual cue showing the entire series of circuits that has been constructed, highlighting how many circuits were built at each length (1, 2, 3, 5, 8, etc.); students are then asked if they can identify a pattern from these numbers.

Therefore, what we are doing is scaffolding the capability to recognize algebraic patterns (the Fibonacci series in this case). Our hope is that, after finishing this activity, students will be able to recognize one type of algebraic pattern and be able to apply that same type of thinking to the types of patterns that they will be facing in their future math lessons. Ultimately, this type of scaffolding is designed to help students come to the realization that they can in fact solve what appears to be complex problems—provide them with mastery experiences to bolster students’ expectancy for success.

To address the value component of the Expectancy-Value theory, students are introduced to eight real-life STEM professionals before attempting to solve the five puzzles. Students choose one of these STEM professionals to be the “team lead” for the puzzle-solving mission. They then watch a short video that introduces them to the STEM professional. In this video, students are able to find out answers to questions such as, “why is your job so awesome?” and “what obstacles have you faced in your path to becoming a STEM professional and how did you overcome them?” Because the models in the interview are young, are in careers that students are apt to view as attractive (e.g., space suit designer for NASA), and are ethnically diverse, we hope that students can readily identify with the role model to whom they are matched and can reap the motivational benefits more easily than if the models were perceived as completely dissimilar to the students. These videos address the value component of the Expectancy-Value theory by illustrating the relevance of algebra knowledge (utility construct) and presenting careers that may be appealing to some students to increase motivation to pursue STEM careers (interest construct).

We hope that, by providing a case study of this NSF-funded project underway at the Harvard Graduate School of Education, we could illustrate heuristics for how motivation theory can inform the design of educational games and other technology.

### **Application of Self-Determination Theory to Mobile Learning**

For the growing field of mobile learning, we believe that there is promising untapped potential when it comes to applying motivation theories to the design of those environments. Part of this optimism stems from looking at the growing literature on how mobile games—and games in general—motivate goal-directed behavior (Gee, 2003; Przybylski et al., 2010). Every day, for instance, players of *Angry Birds* invest 300 million hours in launching birds at towers of bricks and rocks in an effort to destroy pigs (Rovio, 2011) and more than 30 million harvest their crops in the social network game *Farmville* (Cashmore, 2010). When people are asked why they sacrifice other leisure, and perhaps non-leisure, activities to engage in such games, the immediate and most obvious response is simply because they are fun. Motivation can be thought of as being synonymous with the fun that is experienced in games; as such, unpacking what makes games fun can help us in designing educational technology that foster highly motivated learners.

In discussing mobile learning and motivation, we take the perspective of the Self-Determination theory, which posits that motivation arises from the needs for competence, autonomy, and relatedness being met (Deci & Ryan, 2000). We found this perspective to be most appropriate for this discussion for a couple reasons. Research shows that these three needs contribute to inherently enjoyable activities that are therefore intrinsically motivating (Ryan, Rigby, & Przybylski, 2006). This concept of intrinsic motivation is most closely related to what people mean when they say fun. Compared with those pursuing an activity for external rewards such as money, intrinsically motivated individuals are more creative, enjoy the activity more, and process information more carefully and completely (Ryan & Deci, 2000). Furthermore, the portable and personal nature of mobile technology is well suited to address the tenets of the Self-Determination theory of motivation as it already naturally allows for social connectedness (relatedness) and user control (autonomy). These two motivational elements are not addressed in the Expectancy-Value theory but still have important learning implications, especially in the free-choice environments that mobile handhelds are typically used.

Mobile handhelds are portable and personal, encompassing features that are especially applicable to the design of motivating learning environments. Handheld mobile technology has taken portability to a new level as cell phones have allowed for the digitally-tethered life, 24 hours a day, 7 days a week. This constant access frees the constraint of only being able to access data at a certain place such as a desktop computer or a library. Features such as location awareness takes advantage of this portable nature by embedding geotags to alert users of potential details of interest in their

geographical vicinity. Personal and intimate features of mobile handhelds stem from recent developments in tactile features and voice commands. Handhelds are now more responsive to human input as touchscreens react to pressure, motion, and the number of fingers used in touching the devices. Some devices react to shaking, rotating, tilting, or moving the device in space. Voice recognition and responses are becoming more sophisticated and are default features of newer smartphones. These portable and personal features can affect motivation for learning by functioning as new tools that designers can use in enriching learning environments.

One way that mobile handhelds can be used to increase motivation is by enhancing authentic learning. While desktop computers helped contextualize learning by bringing real-world context into the screen, mobile learning, on another level, has allowed for bringing the screen into the context. The Museum of London, for example, offers an iPhone app that allows users to view information and historical images overlaid on modern sites as they travel throughout the city (Johnson, Smith, Willis, Levine, & Haywood, 2011). Similarly, a project dubbed iTacitus (an acronym for "intelligent tourism and cultural information through ubiquitous services") gives users access to a visual time machine as they visit historical locations, such as the Coliseum, pan with their mobile device, and witness an event from the past (Johnson et al., 2011). These learning opportunities can target environments that people choose to engage in, allowing for an increased sense of autonomy. Another advantage of mobile handhelds is that the benefits of face-to-face communication can be paired with the cognitive scaffolds that technological devices afford. The technology-based cognitive scaffolds, such as performance feedback, address the need for competence whereas face-to-face interactions (e.g., augmented reality group activities) address the need for relatedness.

Furthermore, tactile features of mobile devices allow for tangible technology designs that increase motivation. For example, the multipoint touch-sensitive iPad display can be pinched to zoom in or out on an image and can detect when it is being moved or tilted. Such technology may offer unique benefits by allowing children to manipulate objects on the handheld while benefitting from the advantages of technology. For example, the game can support problem solving by introducing a delay after each action to encourage reflection. Or the game can be designed to foster particular strategies by changing the relative ease of moving objects in particular ways. Manches, O'Malley, and Benford (2010) demonstrated how constraining actions using a digital interface such that children could only move one object at a time resulted in the use of more efficient strategies in solving a math problem compared to using physical, non-technological representations. While it is possible to constrain actions using physical devices, it is typically more difficult to design ways to vary such constraints. Mobile handhelds allow for design affordances such as these to scaffold learning, addressing the motivational need for competence.

## Conclusion

It is clear that, for learning to be optimal, students must be motivated. The two theoretical frameworks addressed here provide rigorously studied and theoretically grounded constructs with which researchers and designers can study and create technology-rich activities that enhance the experience of learning. Although we have provided examples of how theories of motivation can be applied to the design of technology activities, there are a great many ways that these theories can be applied. Even more exciting is the fact that technologies can be designed in ways that can allow researchers to test many different experimental variations, providing researchers and designers with empirical evidence for which design decisions may be appropriate for whom under what conditions. We encourage researchers to conduct these types of micro-level analyses, which can provide useful information on designing motivationally optimal environments.

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# Exploring a New Approach to Visual Asset Design

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**Abstract:** This paper will present a tool and a method to help game developers make decisions about creating visual assets such as game characters. It will also present results from a series of studies. The first study utilized this research tool to investigate middle school students' attitudes toward sixty game characters in the area of science, technology, engineering and mathematics (STEM) in commercial games. The second study used the most liked and disliked characters (by gender) determined by the first study in an educational game as science mentors. After presenting the effects of using these characters in motivation of students towards the game, the paper will conclude with research-based implications for educational game designers wanting to maximize motivation through the use of game characters in STEM-related educational games. Readers will also be informed about a method useful for developing visual game assets, and insight about creating characters for STEM educational games.

## Introduction

Designing visual assets usually requires a great deal of intuition and/or experience. The creation process for characters' appearance in video games can be especially challenging. Game characters not only have to fit the character's personality within the narrative, but oftentimes must also look attractive to the target audience. This is even more important for game characters that are not customizable. In these cases, the visual presentation is quite literally a work of art that is presented to the players.

A distinctive design or style of appearance can imprint themselves on players' minds for life. Mario of countless Mario Brothers titles, Gordon Freeman of Half-Life, Lara Croft of Tomb Raider are all well-crafted characters whose image will be remembered by game players. Those characters have established their brands in the minds of gamers, marking their territory, and making them hard to mimic without copying. Looking back on the view of characters as art, this parallels art being associated with branding in other commercial areas (e.g. company logos or mascots).

Some guidelines for designers and artists exist about how to create game characters (i.e. Isbister, 2006). For example, stereotypes, attractive characters, or baby-faced characters may help to achieve the goals of personality. However, innovation is also necessary to establish interest towards a new game. During the design and development process, designers and artists may ask a focus group for their option about characters appearance before deciding which to use in the game. Those same people may benefit from tools that can help them to determine common characteristics among visuals for game characters, as well as to gain insight from users on those visuals.

Similarly, it is oftentimes difficult for researchers to understand a person's reasoning when they make certain decisions. Although methods like think aloud may aid researchers, people may have difficulty verbalizing the reasoning behind a certain choice, while they are making that choice (Wilson, Hodges & LaFleur, 1995). Tools that can help with understanding this process would be useful for researchers. This paper presents a digital tool and a method to facilitate people's thought process and help researchers to understand the reasoning for selecting certain items, in the case of this paper, visual assets, in groups.

In the next section, we will present this digital tool, digital pile sorter (DPS), and pile sorting methodology that the tool is based on. After presenting the tool, we will briefly talk about two different studies: The first study utilized DPS tool to determine middle school students' attitudes towards various STEM characters. The second study used these characters in an educational game. We will conclude with the implications of the results for game design including educational game design on the domain of STEM, as well as discussing possible other uses of the DPS.

## Sorter Tool

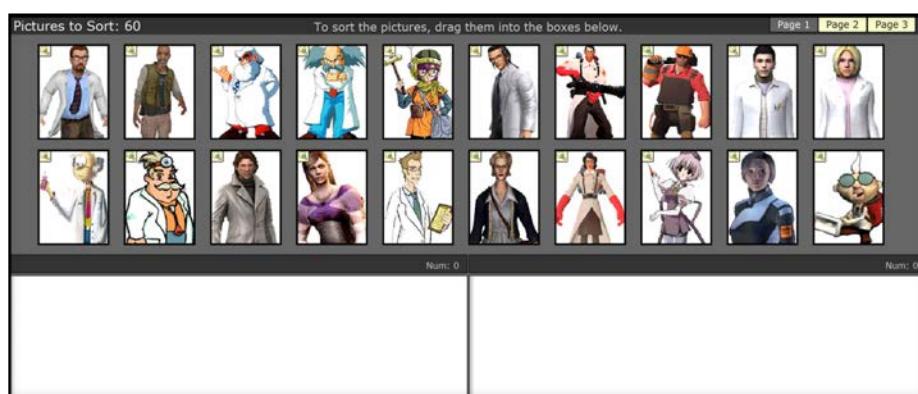
The DPS tool was developed based on the pile sorting methodology (Weller & Romney, 1988). Pile sorting is a method used to understand people's perception and structure of a domain, through an observation of how they classify and group the items of that domain (Bernard, 2002). It is useful for investigating people's perceptions of the similarities and differences among items, and to discover variation in how people define domains. In a pile sort task, participants are asked to sort items into piles. These items can be anything that can be physically sorted into groups. The sorting task can be either a single sort or a successive sort.

Usually, in a single sort, the items to be sorted are randomized for each participant. For example, if these items are words on index cards, the researcher shuffles the cards. Participants are then asked to make groups with the cards in terms of similarity so that most like terms are in the same pile and unlike terms are not. Participants can make as many piles as they want. After the piles have been arranged the participant is asked why items were sorted as they were.

In the successive version, participants are asked to make a certain number of piles, usually two, with the items they are given. Participants are usually asked to group the items based on their similarity, without reference to a specific criteria. The subject decides on what criteria are most salient and determine similarity. Participants are then asked to subdivide the initial piles. The continual process of subdividing pile is repeated until it can no longer occur. This method enables the creation of a taxonomic tree for individuals, a group, or both. The structures produced by individuals can be compared.

The current sorter tool is built using Adobe Flash. The tool has multiple layers researchers or game developers can use to understand peoples' thought processes and attitudes. It allows sorting any number of image files into groups, using successive pile sorting mechanics (Boster, 1986). At the very basic level, researchers can upload image files, which may include pictures and/or words, and ask people to sort them into a certain number of groups based on similarity or based on a prompt in which the researcher is interested. Through iterated pile sorting, people can sort the images into several subgroups. In each level of sorting, researchers can insert multiple questions in the interface to facilitate users' thought processes or to probe their attitudes towards the images in the group (see Figure 2). Participants can zoom in an image to examine it closely. They can also move images between the groups. All of these processes, including the movement of images are time stamped, and recorded in a database for the researcher.

The DPS has been used in three studies so far. We will briefly go over one of those studies in the next section. In one of these studies, Hotaling, Lowes, Stolkim, & Lin (2012) used the DPS to assess middle school students' understanding of sensors. DPS asked students to sort eighteen cards that showed items with captions. Another study was designed to assess the high schoolers' understanding of who engineers are, and what they do. This was in an underwater robotics program that aimed to teach science and engineering concepts (Lowes & Tirthali, 2011). In this study, participants were shown pictures depicting people at work, and then sorted the pictures into one of 3 groups: engineers, not engineers or not sure. These two studies were constrained sorting activities. The last study that we will explain in more detail in the next section used successive pile sorting.



**Figure 1:** A snapshot from Digital Pile Sorter as used in Study 1.

## **Study 1: Determining What Characters to Use for Science Technology Engineering and Mathematics (STEM) Games**

During middle school, students' attitudes toward science, technology, engineering and mathematics (STEM) tend to deteriorate, and continue declining throughout high school (George, 2000; Kotte, 1992). Reasons include students' perception of STEM being difficult and irrelevant (Jones et al., 2000), and scientists being perceived as isolated from the general public (Long & Steinke, 1996).

Social learning theory posits that children can learn cultural patterns of behavior through repeated observations of symbolic models depicted in media (Bandura, 1969). Media images of science influence public attitudes toward science and scientists (NSB, 2006). For many children, videogames are the media with which they spend the most time (Ito et al., 2009; Pew, 2008). Today's children spend much time playing, and there are strong indications that children learn from playing video games (Gee, 2009; Squire, 2008). Attitudes toward STEM can possibly be changed with well-designed game characters, with whom children would identify. Accurate representations of STEM in video games might also be helpful. This study's goal was to establish patterns of character design that may lead to these desired outcomes.

This study had three stages: 1) Identifying and classifying STEM characters in videogames; 2) Finding patterns among the characters that students like and dislike; 3) Investigating affective and cognitive effects of these characters on middle school students when integrated in educational games.

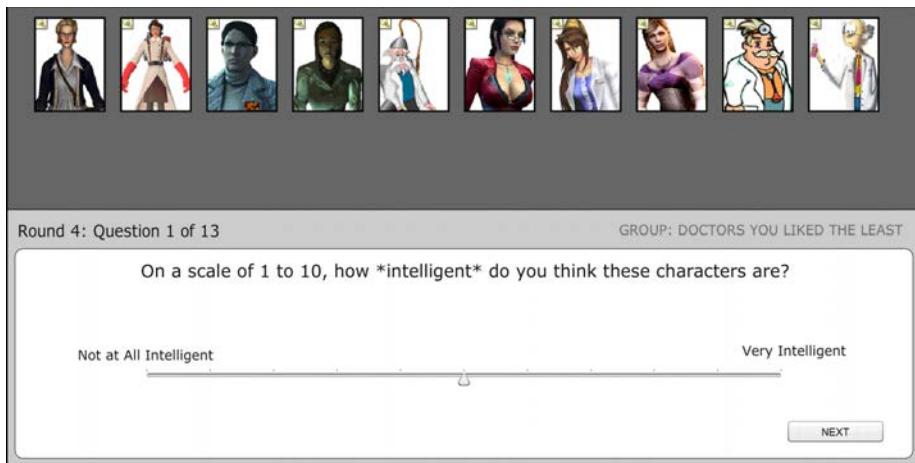
Utilizing the DPS tool, we explored possible patterns in students' perceptions about various aspects of characters in video games. These included perceived trustworthiness of characters as mentors, their intelligence, helpfulness and likability. We identified 317 STEM characters, taken from educational and entertainment video games: 245 male, 72 female. We randomly selected 60 humanoid looking characters among these STEM characters for use in this study with 35 sixth-grade students in New York City. Using the DPS tool, students first divided these characters into two categories based on the type of career they thought the characters represented, and labeled each category. To do that, students dragged the images from upper part to the category they chose. If they were not satisfied with the choice, they would drag it back to the upper section or to the other category box. After they finished sorting all 60 images into groups, they were asked their opinion about the characters in groups. To do so, students were presented with their categories one at a time and asked to make 3 subgroups: characters they liked most, least and weren't sure about. Lastly, they answered ten main questions (e.g., how much would you trust these characters to teach you in a game? On a scale of 1 to 10, how sociable do you think these characters are?) about each group of characters which they expressed like or dislike.

Findings revealed a mismatch between the characters identified as representing STEM careers and the characters students liked. Although all characters had STEM careers in games they came from, only 22 students placed them into a STEM category. Some of the labels for STEM category were doctors, nurses and scientists. Non-STEM labels included heroes, teachers and fighters.

Mirroring previous findings on how students perceive scientists (Barman, 1996), characters perceived as most likely to be in a STEM career were males with lab coats, facial hair and eye glasses. However, students disliked those characters. Four of the top five most liked characters by all the students were females. Moreover, students reported that they would trust the game characters they liked as mentors ( $t = 3.264$ ;  $p < 0.005$ ) and would want to play games that included those characters ( $t = 2.02$ ;  $p < 0.05$ ). This was opposed to those that were presented as prototypical STEM characters, older man with glasses and lab coats, but were not liked. Compared to the characters they did not like, participants rated characters they liked as more helpful, intelligent, heroic, strong, and sociable. This shows clear differences in students' perceptions about different game characters when they like them versus when they don't like them.

We also looked at gender differences in attitudes towards characters in different subgroups participants created. We found that males and females highlighted different characteristics for the characters in the STEM category. Male students think characters they sorted in the STEM category are more intelligent than what females think about the characters in their STEM group ( $p < 0.05$ ,  $t = 2.623$ ). Also, female students think players who play games with these characters more creative than

what males think ( $p < 0.05$ ,  $t = 2.025$ ). The top three most liked characters by males and females are young and attractive images. Male participants especially disliked the stereotypical scientist images, most commonly used in educational games. The next logical step is to find out whether there are any differences in student motivation and learning in an educational video game when using characters students liked versus characters they did not like as determined in this study.



**Figure 2: Answering questions after sorting characters.**

### **Study 2: Using Characters as mentors in an educational game**

The three most liked and disliked characters for males and females (for a total of 12 images) were determined (see Figure 3) as described in the previous section. These characters were used in a follow up study with an educational mathematics game called *Noobs vs. Leets: the Battle of Angles and Lines*. This game was developed by researchers at the Games for Learning Institute and was previously shown to be an effective educational intervention (Plass et al., 2011). The game has six chapters with each chapter introducing the player to a new concept about angles.

This study investigated the effect of choice (in this case choosing mentors) and the effect of varying feedback given by the mentor, with one hundred fifty-four sixth grade students ( $f = 74$ ,  $m = 80$ ) in a New York City school different than the one used in first study. In the beginning of the game, participants in the choice condition were given the option of choosing a single mentor out of six scientist characters. Players were told that this non-player character would give them feedback in the game. Females chose among the six characters that were most liked or disliked by female participants in the previous study. Males received their options in same way. In the No-Choice condition, players were auto-assigned one of the characters from the six that were made available to the choice condition. The assigned characters were distributed in the No-Choice group such that the participants in both groups had the characters in the same proportion [they were actually assigned with probability. There was an 0.8 of chance that students would be assigned to the same character] We will not look at the effects of choice or feedback in this paper. Rather, we will examine how students who had mentors that were liked in the previous study did in terms of achievement and motivation, compared to those who had mentors that were not liked.

We found a gender match between participants and the characters they chose. Specifically, female participants selected female characters as their mentors, and male participants selected male characters as their mentors (See Table 1).

Participant Gender		Character Gender		Total
		Female	Male	
Female	Female	31	4	35
Female	Male	1	40	41
Total		32	44	76

**Table 1: Participant – character gender match when choosing mentors.**

In the game, players filled out a set of motivation questions (e.g., how much fun was this chapter for you?, how much do you want to continue?) after every chapter. They also took paper based pre and

post-tests to assess their knowledge of the topics covered in the game. We categorized the participants into two groups based on those who had one of the “liked” characters (Group 1, n = 94) and one of the “disliked” (Group 2, n = 60) characters. We found these groups not only showed motivational differences towards the game but also achievement differences in the game. In terms of achievement, Group 1 completed significantly more levels in the game than Group 2 did ( $p < 0.0001$ ;  $t = 4.00$ ). Group 1 also indicated more desire to continue playing the game than Group 2 did, both after the first chapter ( $p < 0.05$ ;  $t = 1.996$ ) and the second chapter ( $p < 0.05$ ;  $t = 1.996$ ) of game-play. Although Group 1 still rated their motivation to continue higher than the Group 2, statistically significant differences disappeared after the second chapter. Group 1 also reported that the game was significantly more fun than Group 2 ( $p < 0.05$ ;  $t = 2.154$ ) after the first chapter. Although students reported mentors in Group 1 as being more helpful than the ones in Group 2, this did not reach statistical significance.

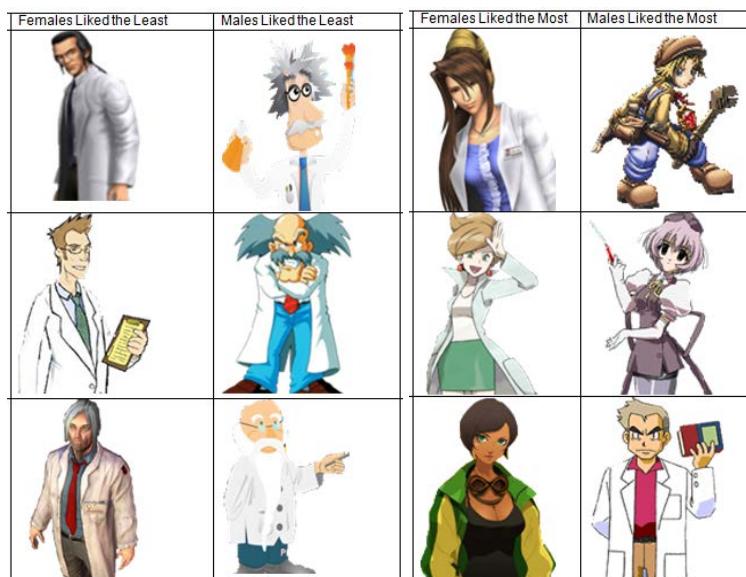
We also investigated achievement outside of the game. A paired samples t-test was used to examine the differences in gain from pre to post test in Group 1 and Group 2. Both groups had gains but only Group 1 had a statistically significant gain ( $p < 0.001$ ;  $t = 3.345$ ). Group 1’s higher gain in test scores might be also caused by their game achievement. The more levels students completed in the game the more practiced they became with the types of questions and concepts.

When we applied Chi-square test to examine the relationship between gender and groups, there was significance (see Table 2 for the number of participants in groups).  $\chi^2 (2, N = 154) = 21.96, p < 0.001$ .

		Liked (Group 1)	Disliked (Group 2)	Total
Participant	Female	31	43	74
Gender	Male	63	17	80
Total		94	60	154

**Table 2: Participant gender – character type**

As a follow-up, we investigated the differences in game achievement between Group 1 and Group 2 for each gender. For males, we found that the difference approached, but did not reach, significance ( $p = 0.072$ ). Male students in Group 1 completed 30.02 levels on average compared to 26.29 levels in Group 2. One possible reason for this lack of significance is the low number of male students in Group 2. On the other hand, when we investigated differences between Group 1 and Group 2 for female students, we found significant differences in game achievement ( $p < 0.005$ ;  $t = 2.893$ ), with Group 1 outperforming Group 2.



**Figure 3: Most liked and disliked characters by males and females.**

## Discussions and Conclusions

“Knowing your audience” is one of the key principles in design. Any tool that can help to understand preferences of a target audience is invaluable. This paper presented a research-based tool, DPS, that is based on the pile sorting method. It also presented snapshots about authors’ experiences with that tool. It also summarized a study that aimed to find out patterns for STEM characters that are liked and disliked by middle school students. This study revealed that the images taken from many educational STEM games fell into the scientist stereotype, older men with glasses, lab coat and facial hair, which were some of the least liked images by the participants. On the other hand, younger looking, attractive female character images were some of the most liked ones among sixty images. Students also rated these characters they liked as more trustworthy, helpful and intelligent. These results imply that these characters may be more motivating for students than the ones that were not liked. The results also bring several questions into consideration:

- Is it possible to come up with design characteristics for STEM characters to be used in educational games in order to motivate students to do better in these games and learn more with these games?
- Are there any age differences for character image preferences (as the target demographic for this study was six grade students)?

This paper also presented a follow up study that was designed to use some of these characters in educational games and test their potential effect on player motivation and achievement. Specifically, the second study tested the effectiveness of using the most liked and disliked characters (by gender) that were determined in the first study. This study showed that when given the chance, players in fact chose the liked characters that were identified by using the DPS tool. Motivational power of playing an educational game with STEM characters that players find intelligent, trustworthy and likable was quite apparent in the beginning levels of the game. Most importantly, the effect of these characters on players’ gain from pre to post test scores demands further research in this area. This study used the character images as mentors who provided feedback to players when they made a mistake. In that sense, students might have paid more attention to the liked characters, therefore, learned more. However, if we modify the role of these characters in the game (for example, instead of mentors they may be player avatars) their effect may change.

We believe that the sorter tool can be used for multiple purposes both in research and design. This would in turn eliminate unnecessary choices and reduce production costs for games. Moreover, the motivational and achievement differences when using different characters as mentors in the game are worth noting. Visual assets such as character appearance are factors that can affect players’ motivation towards the game, especially in the beginning. Educational game designers should keep that in mind given the importance of the “first impressions” when playing a new game. This likely to be especially applicable to educational video games that tend to be viewed less enthusiastically compared to popular entertainment games. In this vein, tools like the DPS can help designers during the design process in a similar way that was used in studies described in this paper.

Both studies reported in this paper have limitations. Although the number of participants was sufficient for statistical analysis, we do need further studies with students of varying demographics to confirm our findings. Luckily, this will be possible if other researchers or educators want to use the DPS tool with their students. The tool will be online and connected to a database to be used by public.

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# Picodroid: Designing and Developing a Physics Game using the Kinect Motion Controller

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**Abstract:** The goal of the *Full Body Physics* project was to create an interactive game-based learning experience that connects middle- and high-school students with critical physics and chemistry concepts using their bodies as a controller. The final product, *Picodroid*, was designed and developed by two successive teams of graduate and undergraduate students in physics, art, education, and computer science, as part of an experiential learning process. Guided by a faculty coach and a subject matter expert/client, the design team made critical design decisions, produced concept art, created the game design document and developed prototypes of two proposed games. The development team, again working with the client, decided to focus on the *Picodroid* concept and carried it through to its finished state. Created for use with the Kinect motion controller and a Windows PC, *Picodroid* challenges competing players controlling “picobots” to assemble subatomic particles to create elements in the periodic table.

## Introduction

Contemporary research on educational games have focused on their affordances; i.e., ways to support students' ability to make meaningful connections to the learning goals (Honey & Margaret, 2011, Squire, 2008; Wilson et al., 2009). This does not mean that the educational game itself must equip students with an explicit means to link the content to be taught or learned; rather, it is the interaction with game that allows learners to increase their interest or motivation, and make further inquiry toward new knowledge. In this instance, motivation does not merely imply “having fun” or engaging in fantasy while playing the game; it also entails curiosity about, and development of, life-long interest toward the subject matter (e.g., science).

With the advancement of technology, learning affordance through digital games may be enhanced through the contemporary human computer interaction design approach (i.e., kinesthetic interactions) to anchor students in a context where a set of interaction elements (physical movement, game missions, storytelling, animations) is introduced to create relevance for students. Once learners develop pattern recognition and knowledge connection with the context, designers can then aims to integrate a series of explicit scaffolding strategies to support learning activities into game missions or objectives to raise interest or motivation towards making further inquiry and acquiring new knowledge.

Our project, *Full Body Physics*, incorporates kinesthetic interactions to afford the needs, abilities, and interests of targeted middle school students while instilling a sense of sportsmanship. The virtual kinesthetic games bypass traditional mouse and keyboard interactions, and instead make use of the body as the controller to interact with the computer game and content. This creative and innovative way to interact with computer games has the potential to transform an enacted classroom into an exciting and highly-motivating learning atmosphere that rewards student inquisitiveness and exploration. An additional advantage of allowing and encouraging students to use physical movement within a class setting, concerns the promotion of student health. Many have expressed concern about children not engaging in enough physical activity, childhood obesity, and the elimination of PE classes due to increased demands for reading/math instruction. Studies have also indicated that children ages 8-12 with higher weight status spend more time in sedentary activities, such as traditional video gaming and computer use, than those with lower weight status (Dietz, 2001; Vandewater, Shim, & Caplovitz, 2004; Walker et al., 2006). Because the proposed virtual kinesthetic game incorporates physical (whole body) movement, it has the potential to synthesize learning with healthy physical activity.

## Project Purpose

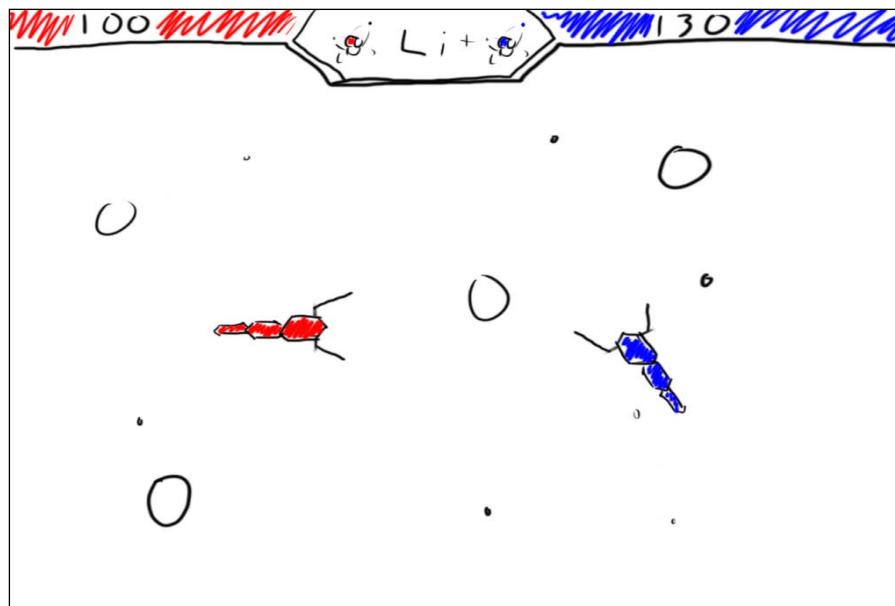
The purpose of the *Full Body Physics* project was to produce a physics-based, kinesthetic video game that utilizes Microsoft's Xbox 360 Kinect interactive controller technology. With Kinect technology users control the game play through the movement of their bodies and voice commands. The design and development teams were challenged to develop a game or games in which middle- and high-school players/learners would engage basic physics concepts in a fun and interesting way, using the Kinect to interact with the world created by the game. The result of this process was Picodroid, a futuristic competitive game that engages students in basic physics and chemistry concepts using their bodies to collect subatomic particles, build elements, and win the game.

## Design/Development Process

This interactive game was created by students at Northern Illinois University's Digital Convergence Lab as part of an experiential learning initiative designed to bring together interdisciplinary teams of talented graduate and undergraduate students to solve real problems for real clients. These student teams are supported by faculty coaches and professional staff who are located in the lab.

*Experiential Learning* projects are typically completed in two academic semesters. Students are recruited, interviewed, and selected by lab staff based on the needs of the project. The first semester consists of students for a design team, and the second semester a development team. The design team focuses on analyzing the needs of the client, looking at best practices in game design, making recommendations regarding technology selection, developing a design document, creating concept art, and developing working prototypes. The design semester culminates with a formal presentation of the design document and prototypes to the client, the lab staff, and the development team. The development team then goes about the business of bringing the concepts and prototypes to fruition, play-testing with the target audience, and presenting the final product to the client.

The client for the *Full Body Physics* project was a coordinator for the university's outreach division and the project was partially funded by a grant from the *American Physical Society*. The design team for this project consisted of a faculty coach, an assistant coach/staff digital artist, an undergraduate art student, an undergraduate physics student, and a graduate student in computer science. In June of 2011 the design team began the process by examining the purposes and goals presented by the project description in the proposal created by the client. Game ideas and design specifications were discussed in concert, with one informing the other. The team members proposed and explored many game concepts, and, with the help of the client and a group of classroom teachers, narrowed it to two primary game concepts (Figure 1). The design team then worked to refine these two game ideas and develop rough prototypes using C#, XNA, Kinect Software Development Kit (SDK) beta, and the Kinect hardware for consideration. The remainder of the semester was spent continuing the cycle of design, development, testing, and redesign. The design team then presented their game design document and two primary prototypes to the development team.



**Figure 1:** Early concept art for Picodroid

In August of 2011 the development team, again made up of graduate and undergraduate (some of which continued from the design team, with the addition of a graduate student from Educational Technology) set about the work of quickly deciding which of the game prototypes to carry forward for immediate development. With the help of the client, the team decided to move ahead on a game concept called *Picodroid* in which players build elements from subatomic particles using picobots in a futuristic laboratory.

environment. The team continued the development cycle including producing game art, music, and programming as well as refining the game mechanics and player interaction. The game was play-tested in several environments, including a STEM fair, and in several middle school physics classrooms. Play-testing results were used to refine and improve the game. The final game was released as a public beta at a formal presentation in December 2011. A beta version of the game was made available on the lab's website, and is playable using an Xbox Kinect on computers with Windows 7 and the Kinect SDK beta. An Xbox is not required for play.

### **State of the Technology**

There were several technical challenges the team needed to overcome in making a game for the Kinect. Primarily, Microsoft does not officially support educational institution the ability to make Xbox 360 games that utilizes the Kinect. While Microsoft has stated the intent to extend the platform to those outside of the AAA game studios, there is no evidence that this will happen in the foreseeable future.

To best ameliorate this, the team developed the games in C# using XNA Game Studio. XNA Game Studio is Microsoft's development tools targeted at independent and educational game developers. XNA Game Studio is a platform that is able to publish games for the Xbox 360, PC, and Windows Mobile Phones. Additionally, the team made use of the official Kinect Software Development Kit (SDK). While this SDK is primarily targeted at making more natural user interfaces, it allows for the development of PC applications that utilize the Kinect and its features. It should be noted that there is no guarantee that these games will work with the Xbox 360 once the official support is release. In light of this, the team has concluded that this is the best possible development course, given the information available at this time.

### **Design Standard Decisions**

The following design decisions provided standards, based on unified concepts, that the team agreed should apply to any game developed for this project. These decisions emerged through discussions with the clients and subject matter experts, prototyping and play-testing, and examination of the various technologies and their capabilities. They included standards for controls, game scope, player interaction, and fidelity of physics concepts.

### **Controls**

By using the Kinect camera as an interface for players to engage in the game, the handheld controller is removed as a medium of game control. This allows for the game to be controlled directly by the player's body. Because of this, it is incredibly important to find a way that allows the game to feel natural, or have a natural way of manipulating the environment. Many of the solutions for these issues are in the gestures the players use to interact in the games. For example, to fire a cannon the throwing motion was selected as a natural analogy to a cannon ball trajectory as opposed to a more artificial motion like an arm movement to the right. In addition, just because you can doesn't mean you should: based on play testing, using feet for repetitive motion should be avoided unless absolutely necessary. It became quite apparent that this quickly becomes arduous and not particularly rewarding.

As the designs for the two primary games evolved, it became obvious that having two distinct motion sets for controlling the games would be confusing if the games were packaged together, so the controls for each were changed to unify the motion sets. While the corresponding motions do slightly different things in each game, keeping the motions consistent allows for easier movement from game to game, a reduced learning curve, and more focus on the game play.

### **Game Scope**

One of the early design standard decisions the team tackled early on was the game scope: whether to create a long, complex game with many layers and deep structure, or multiple smaller games that could be both learned and played quickly. Many existing games were suggested and critiqued as partial models for the game or games described, discussion focused on how these might be played in a classroom environment with 20-25 students, each wanting to both play and assist the players. With turn taking, ease of teacher facilitation, and desire to keep physics concepts explicit and meaningful, the team decided to design 1-2 smaller, lighter footprint games, rather than a long game with involved back stories, complex controls, and potentially hidden physics concepts.

### **Player Interaction**

Reflecting again on the intended use of these games in the classroom, the team decided that the games should be multiplayer, possibly both competitive and cooperative. Several possibilities were discussed including making one game that was competitive and the other cooperative or having settings within a

particular game to change the style of play. In addition, features to encourage “crowd” participation in a cooperative sense should be included wherever possible, in which groups of people watching players might provide input and feedback to the players to help them win the games.

### **Fidelity of Physics Concepts**

The most difficult design decisions to make, and arguably the most important, was how to make a game as accurate as possible in regards to the scientific concepts, while giving the game design enough freedom to make the game fun and interesting. The client and subject matter experts both expressed in direct terms that the most important thing was not to convey incorrect scientific concepts in the game (e.g. supporting stereotypes that are not accurate). At the same time, the game needed to be carefully crafted so that those concepts were integrated into a fun and enjoyable gaming experience. There seemed to be no simple answer, and so it involved much back and forth discussion with the client and subject matter experts. It was eventually determined a certain degree of fantasy was acceptable; however, it was important for the team to rely on the client to determine how and where fantasy was used.

Ultimately, the team chose to design a game that best fit the needs of the environment, audience, and situation, by keeping the game scope smaller and more intuitive, the style focused on a multiplayer game with cooperation as a priority, natural body controls, and accurate scientific concepts with fiction game elements.

### **Picodroid Overview**

This game is intended for use with middle school students (6th - 8th grades) and engages participants with the concepts of atomic structure and stability. The backstory puts players in the labs of *Terse Robotics*, a company in the future that manufactures atoms. The players are tasked with testing unique designs for the latest model of *Picodroid*, a robot that is small enough to manipulate subatomic particles. Each player's goal is to build a stable atom before their opponent. A constant supply of protons, neutrons and electrons are provided, and players must pick up the correct particles to create a stable atom. The first player to complete the atom is the winner of the round. While there are multiple game types, the primary game is concluded after one player manages to win three rounds. There is also a more in-depth variation of the game where each game round is played on a horizontal row of the periodic table. This multiple round game mode, while more time intensive than the primary game, allows player to experience larger elements as the primary game is limited to the first ten.

### **Rules**

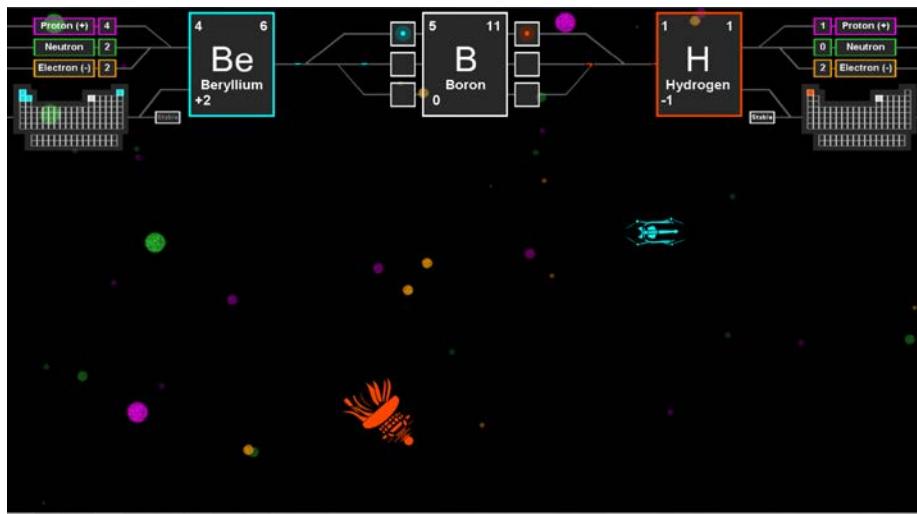
This game has relatively simple rules, which will allow students to quickly get to the core learning without stumbling over an unintuitive interface and obscure rule sets. The players' goal is to build the atom/isotope that is displayed on the top of the screen. The players must collect the correct number of protons, neutrons, and electrons to build the desired atom/isotope. The screen has a randomly generated sea of floating particles that provide a unique player experience each time and prohibits the players from simply memorizing the locations of the particles. The first player to build the target element wins the round. Players who collect too many of a subatomic particle are penalized by reducing their speed for a short duration. This is accompanied by a visual discarding of the particle to let the player know what they incorrectly collected.

### **Strategy**

The game is indirectly competitive. This means the players should focus more of their own progress rather than trying to hinder their opponent's progress. A decision was made not to allow the players' characters to interact directly on the screen, such as allowing one player to block the other player's progress. One player could attempt to collect all of the particles that their opponent needs, however, this strategy has limited uses as players get penalized for collecting too many of any one particular particle.

### **Aesthetic**

The game's audio and visuals are designed to match the story. Due to the futuristic laboratory setting the environment presents a clean and sterile look (Figure 2). Even the character style and animations, which feature some organic inspiration, are designed to have a mechanical appearance. The music and sound effects also take this futuristic approach and are minimalistic and artificial in nature.



**Figure 2: Final Picodroid interface**

## Controls

The onscreen characters are controlled using a combination of the player's left and right hands. The player's right hand controls the direction of the onscreen character. The direction is mapped to the angle of the player's forearm (i.e. the angle between the player's right elbow point and the player's right hand point). The player's left hand controls the onscreen character's speed. If the player raises their left hand higher than their shoulder the onscreen character moves. Initially this was mapped to a scale (i.e. a little high moved slower, while very high moved faster) however this was dropped from the current implementation. Play-testing concluded that players were moving as fast as they could or were stopping to perform a more dexterous maneuver. The observations concluded that a scaled speed was unnecessary to the game and only served to further complicate the controls.

## User Interface

The target and status displays are provided though in a periodic table with the name and symbol of an element, its mass number, atomic number, and charge. Using these numbers, players can determine which subatomic particle they need to build the target atom/isotope. The current status displays detail about which atom/isotope players currently have based on the numbers of subatomic particles collected. In addition, an indicator near the players' status indicates how many rounds the player has won.

## Lessons Learned

Several important lessons can be taken from this game design and development experience and will be used to inform future experiences. The design and development methodology was particularly successful in producing a quality game exceeding the technical expectations of the project manager. The interaction with the client/content expert was critical, providing the necessary boundaries to ensure the teams produced a game that was engaging, but did not stray from reality in ways that would adversely impact students understanding of the underlying concepts.

By creating a game using a relatively new interface structure (the Kinect motion controller), required even the most experienced "gamer" team members to play, troubleshoot, brainstorm far beyond what they may have done if they were creating a traditional PC or console based game with traditional controls. Creating custom gestures that were simple, somewhat intuitive, and did not distract from the game itself proved to be a challenge throughout the process that required much play-testing and even some frustration.

As in many game design processes, many good game ideas were shelved, including some that were well-structured and even prototyped. Many were sacrificed simply because time did not allow multiple development streams, others because of client preferences. It is likely that some of these might be used as the starting point for a new project.

## Moving Forward

Picodroid, now in public beta, will continue to be refined and play-tested for the next several months following which it will be released in "final" form. A research study will then be designed around the game and its implementation focusing on whether students gain a higher or deeper understanding of the underlying chemistry and physics concepts, whether their attitudes towards those concepts are any

different after play, and in addition, whether it was a good game from a design and use perspective. In addition to these foci, careful attention will also be paid to how students play the game, how players interact with each other, how viewers interact with players, as well as how the teacher integrates the game and its concepts into the classroom. To learn more, and to sign up for the Picodroid Facebook site please visit the following web site: <http://www.dcl.niu.edu/index.php?q=content/picodroid>

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# **MathMaker: Teaching Math through Game Design and Development**

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Video of project at <http://vimeo.com/28634159>

**Abstract:** STEM education continues to suffer, especially among minority students attending urban schools. It is becoming clear that to address these challenges we need to break away from traditional paradigms of instruction that stifle student interest and success. This paper presents research findings from one possible solution: *MathMaker*, a curriculum where students learn math concepts and procedures by designing and programming their own digital games. Developed through the mapping and integration of mathematics Common Core State Standards to a range of game design and development processes, the *MathMaker* curriculum comprises a series of activities that guide a student to a deeper conceptual and practical understanding of mathematical principles. *MathMaker* successfully improved the math scores of predominantly low income and minority students in Los Angeles. This game-making curriculum and software solution leverages mathematics as a central language for an authentic and meaningful practice.

## **Background**

While media creation and games are engaging today's young people in extraordinary numbers, disengagement is widespread in American schools. The national mathematics crisis is well documented in test scores, degree attainment, and economic indicators (National Academy of Sciences, National Academy of Engineering, & Institute of Medicine, 2007). The 2009 National Assessment of Educational Progress results show that only one in three eighth graders in the United States are proficient in mathematics, and one in every four is below basic. These low levels of achievement are matched by a profound lack of academic engagement among middle and high school students, particularly those living in urban areas where dropout rates surpass 50%. The situation is more pronounced among low-income minority youth, whose representation in STEM careers is markedly lower than that of their peers (Aud & Hannes, 2010; Vanneman, Hamilton, Baldwin Anderson, & Rahman, 2009).

Additionally, it is well documented that many aspects of math curriculum fall short of their mandate to support students in attaining deeper learning competencies. For instance, a recent article by Rohrer and Pashler (2010) noted, "Despite the empirical support for interleaving, virtually all mathematics textbooks rely primarily on blocked practice." Under this approach students are not in a position to develop the ability to detect when a particular math procedure is appropriate for the problem at hand. Therefore, an alternative approach would be to reverse the "block learning" model by focusing on relevance, meaning, and authentic applications rather than de-contextualized procedures.

To address this challenge, the GameDesk Institute, in partnership with the University of Southern California, developed and studied a new curriculum called *MathMaker*. Since mathematics concepts and procedures are necessary for creating and programming fun and entertaining games, the *MathMaker* game-making curriculum was built to provide an authentic context within which students could foster a deep appreciation of mathematics as a tool for solving personally meaningful problems.

## **Rationale and Approach**

This approach focuses on supporting students in developing an "understanding of mathematics ... as an interconnected set of principles and procedures that have utility for conceptualizing and solving problems" (Linn, 2000). Applying mathematics in the context of game engineering tasks demands that students work with multiple representations of knowledge as a way to interact with mathematical concepts (Dede et al., 1996; Flores et al., 2002; Roschelle, Kaput, & DeLaura, 1996). Game development is ideal because it provides a variety of contexts to apply math, and offers immediate feedback to learners, enabling them to continuously revise their understanding as they work. Moreover, game development affords students endless opportunities to customize and express themselves creatively within the constraints of specific mathematical demands.

In the *MathMaker* curriculum we created, students engage in a carefully structured series of activities that require them to grapple with and apply mathematics standards to a variety of game development based contexts. Students begin very simply by sizing their character and getting the character to move. From the start, students apply simple fractions and proportions to increase and decrease the rate of their moving

character, and strategically control its size and relative proportion to the game environments' fixed pixel resolution. In this way, students immediately begin to cultivate the meaning of fractions in a variety of different contexts and procedures.

With each new math concept and new game development technique the student has the opportunity to further expand his or her ability to create an ever more complex and satisfying experience. Therefore, the curriculum scaffolds students' persistence by leveraging short-term successes to achieve long-term goals. The modules then progressively advance students' mathematical and reasoning abilities by prompting them to identify recurring patterns of math use and then position them to recognize that pattern and use it to tackle a new problem. The goal is to not only create meaning around math use but also foster the students' sense of confidence as a more complex thinker and engineer of entertainment technology, leveraging math as a tool to realize their designs.

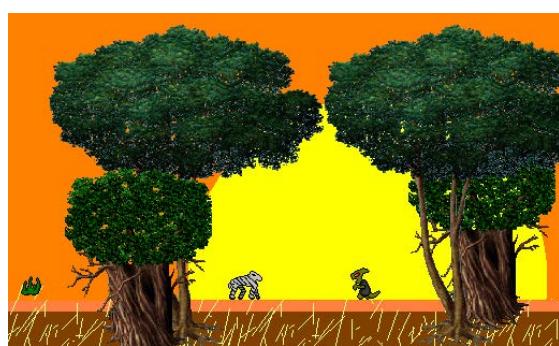
Development of the iteration of the *MathMaker* program that was evaluated at Crenshaw High School in Los Angeles was implemented in two main stages:

**Stage 1 Development:** Modules are designed to equip students with core skills, a sense of confidence, to immediately engage and excite students in game building, and learn basic math skills in context of development. Each mathematical and/or computational step leads to a critical game procedure, behavior, or component that results in a rewarding game function, such as getting a player to move, having a collision trigger a sound, or adding a point to a player's score. Each of these rewarding milestones is designed to build confidence through success and to spark the students' creative capacity.

**Stage 2 Development:** The focus of the second stage modules are to have students apply, manipulate, and modify each math and/or computer science concept so that they gain a sense of control over the concept as a tool for multiple uses. Students are also placed in situations where they are purposely given the wrong instructions (e.g., skipping a step, inaccurate values, misdirection) or where the game "breaks," forcing the student to troubleshoot their game and fix errors. They must logically deduce what is wrong and devise their own solutions. Additionally, they must learn to explain to their teacher and peers, in their own words, the steps for performing a task so that they can identify where the game program went wrong. At these stages the student becomes increasingly reflective about what they are doing and more cognizant of the applicable value of the concepts they have learned.

### **Exemplar MathMaker Methods for Embedding Mathematics in Game-Creation**

We offer the following exemplar methods from the *MathMaker* curriculum to articulate these concepts at work. We also offer snapshots of student-developed *MathMaker* games (Figures 1-4).



**Figure 1: Screenshot of student game developed during MathMaker program.**

**Converting game values for distance and rate:** In certain instances, a math concept will be required to author certain values within the game. For example, ratios and conversions are used to go from a general value to a value that the game recognizes (e.g., pixels-per-second converted to pixels-per-step for rate of movement). Unit conversion is used for myriad design and development needs, such as setting characters to move at different speeds and "jump to" [GameMaker function] specific distances to create a relationship of movement between auxiliary characters, the environment and another player's character.

**Math as a game design mechanic:** Math concepts are also essential for creating successful game designs. For example, in a game like *Food Frenzy* the player has to eat the right amount and type of food to progress to each level. Within this context, ratios become the core game balancing design practice in

ensuring that all the food types and weights are proportional to the totals within the game. If the ratios are not properly configured, the game will become too easy, too difficult, or even impossible.



**Figure 2: Screenshot of student game developed during MathMaker program.**

*Math explicitly used for programming:* In later instances, a mathematical concept will be explicitly tied to the programming. For example, in one of our advanced pilots, students learned the quadratic formula in order to generate a parabola that defined the jump style of their playable character. The students used the quadratic equation to determine the vertex and overall form of the parabola within the Cartesian plane of the game environment.

*Relative distance to optimize a global variable:* Linear equations are used to create an optimization formula in a simple 2D airplane flyer game to determine the shortest distance across a set path for landing the plane for a refuel. In this process, the application of the mathematical concept is repeatedly facilitated as a programmed “global action” throughout a game level based on the airplane’s location and the island on which it is to land.



**Figure 3: Screenshot of student game developed during MathMaker program.**

*Known technology language leveraged to reveal an essential math concept:* To correctly configure a game for different devices (PC screen, plasma screen, the iPhone), the student must understand factoring, resolution and aspect ratio to calculate a game screen size that is compatible with different aspect ratios. Students come to a concrete realization that a ratio is a comparison of two numbers. They come to realize that certain resolutions share the same factors and can be reduced to the same ratio. The authentic context in this case naturally lends itself to variation in procedure, and our research has leveraged that affordance to give students the opportunity to develop conceptual understanding in concert with practical skill.



**Figure 4: Screenshot of student game developed during MathMaker program.**

*Extracting a general rule:* Game authoring is an authentic context for recognizing and abstracting patterns. For example, when moving a character across the game environment using the “jump to position” command, the character moves at different fractions of distance across the screen. Given a certain fraction and room size (pixels of resolution) students must determine the proper x and y values to properly position the character. By varying the fraction and room resolution, students have opportunities to recognize and extract a general rule for calculating the jump distance. In this instance, the students make a series of calculations from which they extract a general pattern and then rule (in this case an equation).

### The Study

The *MathMaker* project studied at Crenshaw consisted of a series of engaging game-creation curriculum units that were implemented to show that historically low-performing students could effectively learn and value mathematics through the *MathMaker* curriculum. The overarching goal of the program was to implement a successful after-school program serving low-income minority students attending schools challenged by high dropout rates and persistently low achievement (e.g., 1% school-wide proficiency in math). The program was additionally designed to create and foster students' identities as technology producers and engineers. In order to assure that the covered material was touching on core standards, students engaged in a carefully structured series of activities that required them to grapple with and apply 6<sup>th</sup> grade mathematics standards.

In the interest of measuring and evaluating the success of the program, we designed and administered formative and summative assessments on math learning linked with 6th grade standards. Mathematics proficiency was assessed with a set of adapted released items from the California Standards Test for 6th grade mathematics. Three measures were administered, each before and after sampled module chapters. Comparisons of the pre-test to post-test results were evaluated for evidence of improvement. Math interest was assessed with an eight-item 5-point Likert scale (portions were reverse-coded) and math self-efficacy and math class interest were measured using three items on a 5-point Likert scale (portions were reverse-coded). Constructed response post-test questions were administered to provide evidence of impact the program had on students' perceptions of themselves in mathematics and engineering.

Please note that t-tests were not involved in the evaluation due to a small sample size that would not register statistically significant and reportable results. As we expand the program, we will also expand our evaluation activities to document program impacts statistically, and in comparison to control groups.

### Development Observations

To develop the *MathMaker* program, the GameDesk Institute created a game-learning curriculum development team bridging teachers from a network of schools, game developers, assessment specialists, and content experts in math and computer science. The team developed a curriculum development protocol for generating 6<sup>th</sup>-grade modules for the *MathMaker* project and intended outcomes. This protocol allowed the linking of each specific math process to a game development process in GameMaker software, and to link those processes to an entire scope and sequence of engineering and math learning activities.

We believe that this particular collaborative expertise is remarkably unique in this field. To our knowledge, there is no prior literature describing any precedent for this type of development process or intellectual capacity. The team has developed a unique collaborative process and design protocol linking math common core standard to game development and design activities and an effective process for rapidly researching and developing math-driven game-authorship curriculum and game templates that are engaging, educational, and fun.

## Implementation

GameDesk implemented this curriculum at Crenshaw High School in spring 2011 as an after-school for-credit course (Figure 5). The class met four times a week for 10 weeks and was supported by an part-time art teacher and full-time math teacher from the high school.



**Figure 5: Students at Crenshaw High School participating in MathMaker program.**

The site where the program was implemented is a large urban high school. It enrolls over 2,000 students, of whom 64% are Black and 34% are Latino/a. Over three-fourths of the school's students come from low-income homes. Among the challenges faced at this site is 2% proficiency in general mathematics, based on the California Standards Test (CST) scores. The school's Academic Performance Index (API) hovers in the mid-500's (scores in the 800's are considered good), and fewer than 2 in 3 students graduate in four years. Within the program; a sample of ten of these students, approximately 60% were Black and 40% were Latino/a, were tracked and provided data for the measures administered.

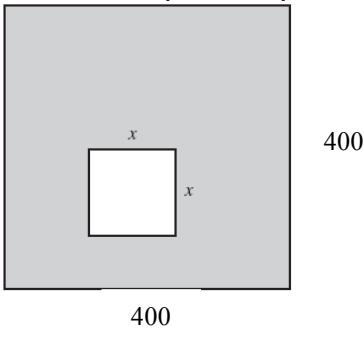
An evaluation study was conducted to examine whether the pilot implementation offered evidence that the *MathMaker* curriculum met its goals of (1) improving students' mathematics proficiency; (2) increasing students' levels of mathematics interest, mathematics self-efficacy, and math class interest; and (3) positively impacting students' identities regarding mathematics and engineering. More importantly, the study sought to determine whether students' knowledge and motivation gains would transfer to traditional standardized tests and measures. All measures were chosen for their demonstrated validity and reliability metrics.

### Program Goal 1: Mathematics Learning

In creating the game-making math curriculum, the GameDesk Institute aimed to increase students' proficiency in ten of the 6th grade California mathematics standards. These standards addressed concepts and procedures around number sense, fractions, ratios, and inequalities, and linear equations. Each standard was analyzed for linkages to game-making activities.

In the assessment component of this project, the Institute investigated whether students would be able to transfer the mathematics knowledge they gained in the game-making activities to state standardized tests. If so, this would provide compelling evidence that the *MathMaker* curriculum was meeting its mathematics learning objectives.

To ascertain whether students' mathematics proficiency improved by participating in the *MathMaker* program, a series of assessments were administered. The tests were administered twice, once before and once after the curriculum was implemented. The mathematics assessments administered in this evaluation study consisted of ten released test items from the California Standards Test (CST) in 6th grade Mathematics. Released items are test questions which have been administered on previous tests, and which are made available to the public. The state provides released test items for each of the state mathematics standards. The evaluation study was thus able to collect released test items associated with each of the standards targeted in the *MathMaker* curriculum. Some of the items were adapted to a game context. For example, one CST item asked, "The weekly milk order for the Tranquility Inn includes 40 gallons of low-fat milk and 15 gallons of chocolate milk. What is the ratio of the number of low-fat gallons to chocolate gallons in the Tranquility Inn's weekly milk order?" The adapted item read, "The game spec for Tranquility Maze includes 40 robots with blinking lights and 15 goblins. What is the ratio of the number of robots with blinking lights to goblins in the Tranquility Maze spec?" (Table 2)

Standard	Test Item
6NS2.3	<p>There are 190 castles in a GameMaker game. What is the least number of rooms needed to hold all the castles if each room holds exactly 8 castles?</p> <p>A 22 B 23 C 24 D 25</p>
6AF1.2	<p>In a maze game, moving at regular speed costs 5 points per minute and moving at high speed costs 12 points per minute. Which expression gives the total cost in points for <math>x</math> minutes of regular speed and <math>y</math> minutes of high speed?</p> <p>A <math>5x + 12y</math> B <math>5x - 12y</math> C <math>17(x + y)</math> D <math>17xy</math></p>
6AF3.1	<p>A square object with a side of <math>x</math> is inside a square game screen with a side of 400 pixels, as pictured below. Which expression represents the area of the shaded region in terms of <math>x</math>?</p>  <p>The diagram shows a large square with a side length of 400 pixels. Inside it, there is a smaller square with a side length of <math>x</math> pixels. The area between the two squares is shaded gray.</p> <p>A <math>1600 + x^2</math> B <math>1600 - x^2</math> C <math>1600 - 2x</math> D <math>1600 - 4x</math></p>
	<p>The game spec for Tranquility Maze includes 40 robots with blinking lights and 15 goblins. What is the ratio of the number of robots with blinking lights to goblins in the Tranquility Maze spec?</p> <p>A 3:1 B 5:1 C 5:3 D 8:3</p>

**Table 1: Example Test Items**

**Results:** The first test was administered the first week and last week of the program. At the start of the program, students scored an average of 32%. At the end of the course, the students' average was 54% on this test. Moreover, the great majority (80%) of students improved. This outcome shows clear learning gains over the course (Figure 6).

The second test targeted number sense and was designed to accompany a 1-week unit within the course on number sense in which students programmed characters to jump across the screen using distances equivalent to specific fractions of the screen width. On this test, the pretest average was 23% and the posttest average was 43%; over 80% of students improved from pre to post. Likewise, the third test targeted ratios and accompanied a two-week unit within the game-making curriculum module. The average pretest score was 54%, and the average posttest score was 68%; over 70% of students improved from pretest to posttest.



**Figure 6: Learning gains from MathMaker course.**

### **Program Goal 2: Mathematics Self-Efficacy and Interest**

The *MathMaker* program also aimed to (1) increase students' confidence in their mathematics ability, (2) increase students' interest in math, and (3) improve students' interest in math class. The first goal reflects the importance of self-efficacy, which refers to a person's confidence in their ability to complete a given task. Research has repeatedly shown that high levels of self-efficacy are associated with higher achievement. Students build their self-efficacy in mathematics through experiences of personal success, as well as by seeing their peers succeed. Because the mathematics in the *MathMaker* curriculum is so closely tied to a real-world context, and because the curriculum was created to offer students many opportunities to succeed, it was expected that students would gain confidence in their mathematics abilities.

There was also reason to expect students' math interest and math class interest to increase. The rationale for hypothesizing improved interest was that by learning and applying mathematics in a personally meaningful context (i.e. game making) students would see the utility of math for their own goals. In addition, the *MathMaker* curriculum is designed to help students deeply grasp the big ideas of mathematics, starting from real-world contexts. This approach was suggested to lead to better understanding, which in turn would foster the student's continued interest.

**Assessment Approach:** Math Interest was assessed with an eight-item 5-point Likert scale that was previously validated by Riconscente (2010) (reverse-coded). Math Self-Efficacy was measured using three items on a 5-point Likert scale, based on Bandura (1997). To tap Math Class Interest, three items were administered on a 5-point Likert scale. This measure was adapted from Riconscente (2010).

**Results:** The mathematics interest, self-efficacy, and math class interest measures were administered at the start and end of the entire implementation. Average scores for all three measures increased from pretest to posttest. Mathematics interest went from 3.8 to 4.1, mathematics self-efficacy increased from 3.3 to 3.5, and students' average math class interest increased from 2.6 to 2.8. Self-efficacy and interest are considered relatively stable traits of individuals, not easily prone to change. The fact all three measures yielded increases after such a short implementation period demonstrates the ability of the program to positively impact students' motivation for mathematics.

### **Program Goal 3: Confidence and Identity STEM**

The third goal of the *MathMaker* program pertained to students' senses of themselves as engineers and mathematicians. This outcome was investigated qualitatively, with the aim of capturing students' own perspectives on the ways that creating games helped them see their mathematics ability and engineering career opportunities in a different light. At the end of the course, students were asked to respond to several constructed-response questions, including "How did the GameDesk course change your ideas about being an engineer?" and "How did the GameDesk course change your self-confidence in math?"

**Results:** The majority of students offered evidence that the course had a positive effect on their confidence in mathematics and in their identity as engineers. These results provide validation of the survey data that showed increased math self-efficacy (confidence) and personal relevance (interest). Specifically, students' constructed-response comments documented the positive impact the program had on their STEM persistence, confidence, ambitions, and career awareness (Table 2).

It changed it by making me want to get better in my math subject.
Made me feel like I can learn it, I thought I couldn't so now I know I have hope in learning.
It gave me more confidence in math.
I learned that I knew more than I thought.
I thought an engineer was something like building cars or something ... but now I know it can be something like this and also that math is very much needed in becoming an engineer.
It made me think I can really be an engineer. I think I developed good skills.
It made me want to design games and become a programmer.
It made me want to go to college more.

**Table 2: Example responses from open-ended items**

### **Moving Forward: Re-synthesizing Knowledge and Expanding the Creation Driven Model**

- The next stage of this project will be to design an individual culminating game that meets specific criteria by re-synthesizing previously constructed knowledge.

Students will be given examples of the how the final game should play and all of the functions that it has to perform. Our current design is to develop an *Angry Birds* clone that would have all math concepts previously demonstrated in preceding modules. For example, the parabola would be demonstrated in the grasshopper jumping action in the side-scroller module, etc. The goal will be to challenge the student to re-architect previous math knowledge in service of creating a game without any step-based prompting.

The *MathMaker* module has been designed to help students apply mathematics within an attractive and familiar real world context and thereby help them create meaning around math as a tool for development. Motivated by these challenges and this early promise in data, there's an implicit drive in the *MathMaker* program to embody, at the micro-level of the classroom module, what can be a macro-level transformation: schools becoming sites of experimentation, discovery and creation driven by student interest, grounded in educational standards, and facilitated by technology. It shows us a potential pathway to bridge existing gaps in student engagement and participation.

### **Summary**

The purposes of the program and study were to examine whether the GameDesk developed *MathMaker* game-making curriculum modules could improve urban minority students' mathematics proficiency, interest, and confidence, and promote positive attitudes toward STEM careers. There was clear evidence of mathematics learning as assessed by state standardized test items. Moreover, quantitative survey results demonstrated a clear increase in students' attitudes toward math and their own ability to be successful in math and engineering. The results of the evaluation provide promising early evidence that *MathMaker* succeeded in improving students' math knowledge and motivation, even in a short-term implementation and an after-school context. Importantly, this project demonstrates the effectiveness of game-making for teaching and engaging students in STEM fields, and contributing to a necessary revision of our educational model. Having been successfully implemented in a predominantly African American and Latino/a classroom, *MathMaker* also demonstrates how this style of education can foster student excitement and achievement within historically disadvantaged communities severely underrepresented in STEM fields.

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# Using Gaming Paratexts in the Literacy Classroom

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**Abstract:** This paper illustrates how digital game paratexts may effectively be used in the high school English to meet a variety of traditional and multimodal literacy outcomes. Paratexts are texts that refer to digital gaming and game cultures, and using them in the classroom enables practitioners to focus on and valorise the considerable literacies and skills that young people develop and deploy in their engagement with digital gaming and game cultures. The effectiveness of valorizing paratexts in this manner is demonstrated through two examples of assessment by students in classes where teachers had designed curriculum and assessment activities using paratexts.

Valorizing children and young people's 'gaming literacy' (Salen, 2007; 2008; Zimmerman, 2009) by including digital games is paramount in assisting practitioners in drawing upon pupils' out-of-school literacy practices to support the acquisition of traditional and multimodal literacies. While the connection between digital gameplay and multimodal literacy is clearly established (Buckingham & Burn, 2007; Zimmerman, 2009), in this paper we argue that the digital game 'paratext' (Consalvo, 2007) is central to capitalizing on pupils' out-of-school literacy practices.

In the context of digital gaming, the 'paratext' is an umbrella term covering ancillary media about digital games made by and for players (Consalvo, 2007: p. 8). Digital game paratexts provide practitioners and pupils with a strong conceptual link between gaming literacy and the acquisition of traditional school literacies. Digital game paratexts are easily accessible print and multimodal texts that connect gaming with curriculum-based literacy outcomes due to their relevance. Drawing on two urban case studies from a three-year project funded by the Australian Research Council we demonstrate the effectiveness of including digital game paratexts within the English curriculum (1). When pupils read, write and design digital game paratexts, teaching and learning can valorize their multiple literacies in ways that support the acquisition of traditional print-based literacy practices that are necessary for academic success.

## Digital games and literacy

Current research argues that digital games motivate young people in ways that formal education does not (Amory et al., 1999; Dondlinger 2007; Facer et al., 2003; Gee 2003; 2007; Swartout & van Lent, 2003). More specifically, digital games increase players' ability to manage 'spatial representation' and 'iconic skills' (Greenfield, 1984), visual attention (Greenfield, 1984; Greenfield et al., 1994), and problem solving (Greenfield, 1996; Prensky, 2001; Rieber, 1996; Squire, 2002). Digital gameplay also develops skills that encourage experiential and exploratory learning (Betz, 1995; Gorri & Medina, 2000), provides players with conceptual understandings of active learning strategies (Kirriemuir & MacFarland, 2004), and fosters social engagement and the development of collaborative skills (Galarneau & Zibit, 2007; Manninen, 2002; Squire, 2003). Other relevant studies highlight the educational potential of games (Egenfeldt-Nielsen, 2004; 2007), the experience of the player during play (Ermi & Mayra, 2005; Gee, 2003; de Kort & IJsselsteijn, 2008), and learning to play in games (Pelletier & Oliver, 2006). Through playing digital games, children and young people are introduced to contingency and risk, and explore issues of identity, possibility, and subjectivity (Walsh & Apperley, 2009). Many considered the skills, knowledges, and literacies learnt through digital games crucial to education and citizenship in the 21st century (Galarneau & Zibit, 2007; Kahne, Middaugh, & Evans, 2009; Raphael et al., 2010; Zimmerman, 2009). The positive assessment of digital games is also recognized outside the realms of educational scholarship and game studies. For example in 2008, the European Parliament's Committee on Culture and Education called on the Committee of Internal Market and Consumer Protection to incorporate the suggestion that digital games can have substantial educational advantages and be beneficial in developing intellectual capabilities and creative, linguistic, and strategic skills.

Our current understanding of gaming literacy emerges from valuable iterations of 'game literacy' (Facer et al., 2003; Buckingham & Burn, 2007), 'gaming literacies' (Salen, 2007), and the use of the term as an approach to literacy based on game design (Zimmerman, 2009). The term game literacy has been used as a means of provoking sustained discussion of how games and gaming culture can

be studied with an emphasis on a ‘theory that addresses both the representational and ludic dimensions of games’ (Buckingham & Burn, 2007: p. 345). We are not simply interested in how digital games work, but how they support a performative and transgressive learning stance based in play, reflective of the status of games as ‘dynamic rule-based systems’ (Salen, 2007: p. 307). Gaming literacies are the key to understanding the skills required to be considered literate in the twenty-first century (Beavis et al., 2009; Zimmerman, 2009).

Gaming literacies are developed through gameplay and engagement with digital game cultures. During gameplay, children and young people draw on their gaming literacies to accomplish difficult but motivating tasks and develop new knowledge by navigating the complex, changing virtual environment. Through their engagements with digital games, players often develop sophisticated ‘gaming capital’ (Apperley, 2010; Consalvo, 2007; Walsh & Apperley, 2009) demonstrating differing levels of expertise with a variety of digital games across a range of possible platforms. The difficulty of mastering some of the challenges set by digital games often leads to players exchanging expertise and information in order to master tasks and objectives. Gaming cultures are a key context for this exchange, particularly online gaming communities where players can use, share, and produce digital game paratexts.

### **Paratexts for literacy education**

The term ‘paratexts’ embraces a wide range of products, activities and popular culture texts that reference digital gameplay. Paratexts are systems of media products—‘communication and artefacts’ (Consalvo, 2007: p. 8)—emerging from game cultures, which frame the consumption of digital games (see also: Ashton & Newman, 2010; Jones, 2008; Kline et al., 2003; Newman, 2008). Paratexts are integral to the history and success of the digital games industry (Consalvo, 2007; Kline et al., 2003) as they are used to cultivate gaming cultures through various official and unofficial publications. Widespread access to the internet, player produced guides, FAQs, and other creative products has since become common: *GameSpot* ([www.gamespot.com](http://www.gamespot.com)) has over 40,000 digital game FAQs, guides, and walkthroughs; over 250,000 cheat codes; and over 100,000 reviews contributed by the community of game players. When children and young people read, research, consume and design paratexts, they are engaged in relevant literacy practices, making these activities a fluid example of situated learning (Gee, 2003; Stevens et al., 2008). Digital game paratexts ‘shape players’ expectations of what it means to play a game properly or improperly’ (Consalvo, 2007: p. 183).

We argue that paratexts are equally important for understanding gaming literacies. Acquiring gaming literacy does not just involve learning how to play digital games, but also the navigation, comparison, and reading of the “official” and “unofficial” paratexts and contextualizing the information contained in light of the credibility of the particular sources. Alvermann (2001) provides a compelling example of a pupil’s eager consumption of paratexts with her discussion of Grady, a ninth grader who disliked reading, but spent his Thanksgiving vacation poring over a *Pokémon* training manual in order “to get ahead” in his gaming skills. The production and design of digital paratexts also supports the development of technologically complex skills and literacy practices. This includes the design and redesign of digital games and the use—and modification—of software, and leads to basic familiarity with tasks such as copying and saving data files, connecting to networks, and burning DVDs or CD-ROMs. This demonstrates how gaming literacy facilitates and relies on technical literacies through players’ engagements with digital game paratexts.

Paratexts are often descriptions, guidelines, instructions, and strategies for digital games. However, they should not be regarded as merely practical, but also as imaginative and creative outputs that include writing, digital artwork, visual and audio design, and new game designs (see: Consalvo, 2003; Lowood, 2006; Newman, 2008; Schott & Burn, 2007). This demonstrates how paratextual production is grounded in complimentary proficiencies that draw on children and young people’s print-based and multimodal literacy practices that are important to literacy pedagogy. While the pedagogical value of reading, writing, and designing paratexts is clear, we argue that further work is necessary to re-situate these activities and practices in the classroom.

### **Context for introducing paratexts in the literacy classroom**

Through a case study approach, we worked alongside two urban secondary English teachers who believed incorporating digital games into the English curriculum would engage pupils in relevant reading, writing, speaking, listening and multimodal design activities. The project utilized a practitioner action research (PAR) method. During the action research cycles which ran from mid 2007 to mid

2009 it became evident that digital game paratexts were familiar and significant to pupils. Through discussions with the teachers, we agreed the reading, writing, and designing of digital game paratexts would offer a tangible means by which to genuinely capitalize on pupils' out-of-school literacy practices, to intentionally valorize their gaming literacies and provide a platform to introduce digital games into the curriculum.

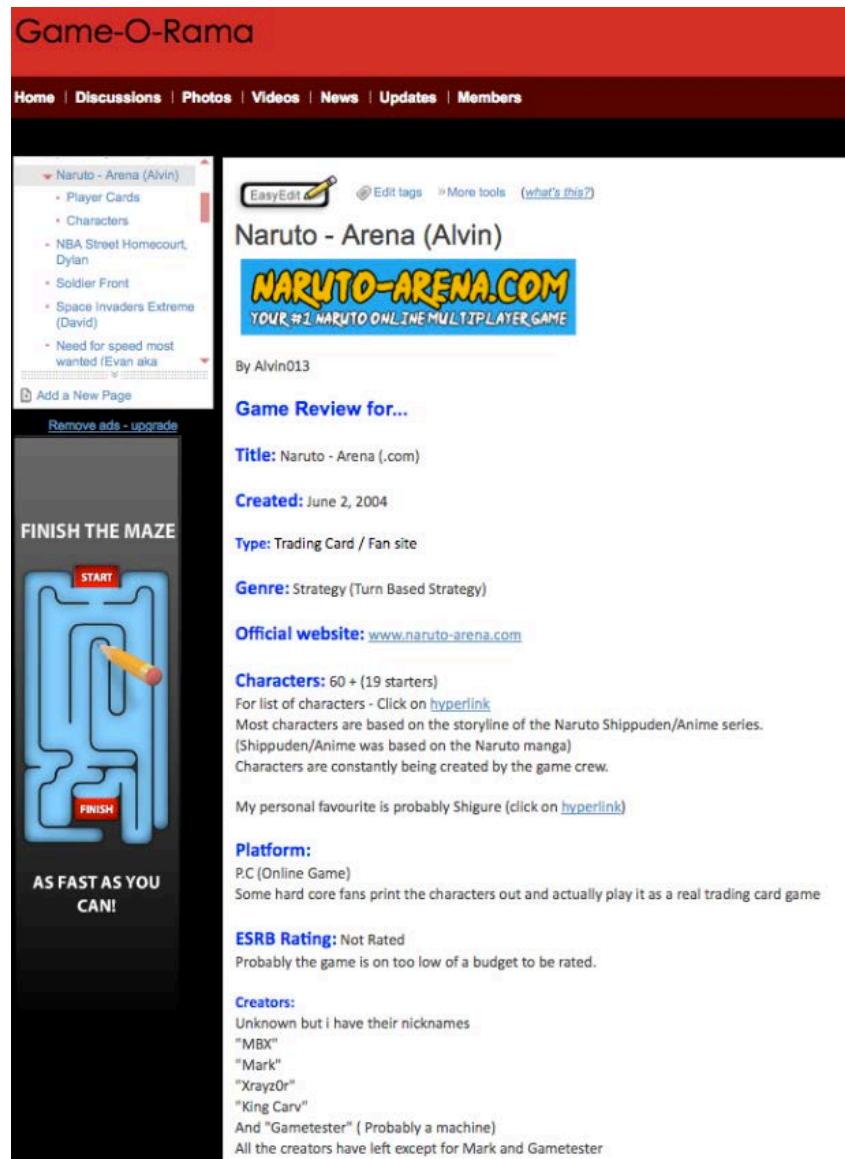
The situating context for this project was a visit to *Game On!* (see King, 2002) at the Australia Centre for the Moving Image (ACMI) in Melbourne, Victoria. The exhibit chronicles the medium's development from pre-commercial experiments to a multibillion dollar global industry. We chose *Game On!* as a catalyst to spark the pupils' interest, and to support the teachers' initial professional development by extending their general knowledge of digital games. Pupils also visited the ACMI Gameslab, where together with their teachers, we observed them play *The Elder Scrolls IV: Oblivion* (Bethesda Softworks, 2006), and a section of the best independent games from the 2007 Independent Games Festival, including *Aquaria* (Bit Bot, 2007), *Everyday Shooter* (Queasy Games, 2008), and *Samorost 2* (Dvorsky, 2003). Observing students playing digital games with the teachers was paramount in demonstrating the complexity of gameplay and the literacy practices involved. As a result the teachers were able to see firsthand how digital games established a context for situated, collaborative learning. This was the first step in designing specific class-based projects that incorporated teachers' emerging knowledge about digital games and available paratextual resources that satisfied their classroom requirements to meet state benchmark standards in literacy.

In the first school, we worked with Paul, who taught English to a small cohort of 'at risk' year seven pupils who struggled with traditional print-based literacies. Paul planned a digital games project where he adapted Freebody & Luke's (1990) four resources model for literacy learning. This required pupils to take up the four roles of the reader: code breaker; text user; text participant; and text analyst in their research. As code breakers, pupils explored how they played the digital game and its rules. In the role as text users, pupils were making meaning by comparing different games and gameplay across different platforms. As text participants, pupils interrogated the digital game's purpose, narrative, genre, and their own role(s) in the game. Finally, as text analysts, they explored why certain games were enjoyed over others and how digital games and the gameplay experience could be improved. Pupils researched digital games by considering the platform they played on (Nintendo DS, PC, Sony PlayStation 2, Wii, etc.), and then by playing and researching games across platforms, evaluating the usefulness of digital game paratexts including walkthroughs, reviews and FAQs.

The project's final assessment was a presentation that included a PowerPoint slideshow. Paul and his pupils generated a list of options for the presentation, including: completing a character analysis by designing character using *The Sims* (Maxis, 2000); filming or writing a walkthrough; arguing for a favourite game/character/platform; describing a scene from a game; recounting a section of a game's narrative; or teaching (and recording) another pupil through a level. Paul valorized pupils' gaming literacy in terms of school-based literacy practices, by designing the assessment in a manner that resonated with their existing paratext use and production by requiring pupils to integrate writing, reading, speaking, listening, and multimodal design activities. The slideshows demonstrated pupils' sophisticated gaming metalanguage through their evaluation of different actions, designs, situations, and systems. They also analyzed the technical details of the game, including the software interface and the inputting of information through the hardware. This assessment gave them the opportunity to present research in digital, print and speaking modes that incorporated writing, multimodal design, public speaking, listening to and responding to peers' feedback. Importantly, Paul carefully considered how this assessment task would provide students with opportunities to satisfy and even exceed year 7 English benchmarks of the Victorian Essential Learning Standards (VELS).

Paul was taken aback by the intense passion for digital games, even among pupils who had given no previous indication of interest in the topic. One pupil, James—who rarely produced any writing—spent an extended period of time researching *Dragon Ball Z Supersonic Warriors 2* (Banpresto, 2004). To prepare his slideshow he used downloaded screen shots from gaming sites, custom animations, detailed descriptions of cheat codes and macros, and strategic information on how to play the game. His PowerPoint is a digital game paratext that demonstrates a considerable amount of reading and writing, the sophisticated deployment of research skills, and multimodal design proficiency. This games-based assessment task provided James with the opportunity to draw on his existing out-of school literacy practices, gaming literacies and experiences of digital gameplay to achieve success with traditional school-based literacies.

In the second case study, Maureen—who, unlike Paul, was working with a standard cross-section of students—redesigned the literacy curriculum allowing a group of year 7 boys to design, play, and research digital games. The unit was organised into two distinct sections where pupils first engaged with digital games by visiting the *Game On!* exhibition. Visiting the exhibition allowed Maureen to valorize gaming literacy by highlighting to her pupils the cultural significance of digital games, particularly because the exhibit was evidence of a strong interest in digital games from an ‘official’ adult perspective. Then students joined a virtual learning environment focused on their individual gaming practices and research. The ‘Game-O-Rama’ wiki offered pupils’ a virtual space that valorized gaming literacy by drawing on the proficiencies that they had developed as users and producers of paratexts through engaging, exploring, and extending print and multimodal literacies. Pupils authored wiki pages on elements of game design character development, colour, genre, iconography, movement, plot, point of view, and sound. Maureen taught pupils mini-lessons on authoring reviews of digital games by providing model texts she sourced from *GameSpot*. Then they wrote reviews, including key information about individual games, and then posted them on the wiki for peer-review. On interview, pupils reported they enjoyed authoring and designing the game reviews and participating in the wiki. Figure 1. (below) is a screen-shot from a pupil’s review of the fan-made game *Naruto-Arena* ([www.naruto-area.com](http://www.naruto-area.com)). The pupil’s review is a digital game paratext with a detailed, persuasive discussion of *Naruto-Arena* that drew on his out-of-school knowledge and metalanguage of digital and card games, media (anime), and fan cultures. This assessment task provided the context for the pupils’ to demonstrate and extend their proficiencies in traditional literacies and multimodal design through the presentation and combination of text, images, sound and embedded video.



**Figure 1: Gaming wiki page**

Through discussions with Paul and Maureen, in-class observations, and interviews with pupils, we gained valuable insights into the demands of introducing digital games and paratexts into the school curriculum. We realised practitioners face considerable challenges when including digital games in classrooms and other settings: accessibility, bias against digital games, inadequate technical and administrative support, and perceptions about appropriate content. However, we believe that using paratexts in the classroom is a viable alternative to using digital games themselves provides practitioners with a way of leveraging children and young peoples' interest in digital games to support school-based print and multimodal literacy practices whilst also avoiding the possible costs associated with the technical infrastructure and support necessary to use digital games in the classroom. Technology issues aside, many educators remain biased against digital games, even to the extreme of arguing that they inhibit learning. In the face of such attitudes, paratexts present practitioners with more palatable way of incorporating and capitalizing on digital games in the classroom and curriculum. Using paratexts, they can successfully design curriculum that includes the learning and literacy activities associated with digital games and game cultures, and valorize and extend pupils' out-of-school experiences in ways that allow them to experience success in traditional school-based literacy practices.

## Conclusion

A great deal of scholarly work indicates that digital games have significant educational value, particularly in the area of literacy. Furthermore, they have an important role to play in classroom activities. The two case studies show how teachers have successfully capitalized on gaming literacy through developing curricula focusing on digital game paratexts. The available activities in both case studies included the reading, writing, design and use of paratexts. These case studies demonstrate how by valorizing pupils' out-of-school literacy practices teachers were able to produce curriculum that developed pupils' print-based and multimodal literacies and met key assessment criteria.

The use of digital game paratexts is a practical starting point for introducing digital games into the curriculum for two reasons. First, because paratexts require less experiential and technical knowledge of digital games to teach they are easier for practitioners unfamiliar or distanced from the cultures of digital gaming to integrate in their teaching and learning activities. Second, because children and young people are already familiar with paratexts—as users, not necessarily as producers—from their leisure practices. Our goal is to enable and encourage teachers and practitioners to valorize children and young people's gaming literacies by developing curricula that addresses the relevance of digital games to children and young people's lives.

## Endnotes

- (1) *Literacy in the digital world of the twenty-first century: Learning from computer games* (Beavis, Bradford, O'Mara, & Walsh, 2007–2009) was funded by the Australian Research Council. Industry Partners: The Australian Centre for the Moving Image, The Victorian Association for the Teaching of English, The Department of Education and Early Childhood Development, Victoria. Research Fellow: Thomas Apperley.

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# **Jerked Around by the Magic Circle— Clearing the Air Ten Years Later**

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**Abstract:** Game studies scholars seem obsessed with slaying the mythical Magic Circle Jerk. But does this person really exist? In looking back at the origin and uses of the “magic circle” concept, this paper also looks into the nature of design discourse and interdisciplinary exchange.

## **Preface: The Magic What?**

A broad strokes definition: The magic circle is the idea that a boundary exists between a game and the world outside the game.

Outside the magic circle, you are Jane Smith, a 28 year old gamer; inside, you are the Level 62 GrandMage Hargatha of the Dookoo Clan. Outside the magic circle, this is a leather-bound football; inside, it is a special object that helps me score—and the game of Football has very specific rules about who can touch it, when, where, and in what ways.

Is the magic circle a verifiable phenomenon? A useful fiction? A ridiculous travesty? And who really cares? This essay endeavors to answer these questions by looking at the history, the use, and the misuse of the term. And along the way, I offer some correctives to how we think about the concept, about game design theory, and about the more general study of games.

## **Shoot Me Now**

At game studies conferences, I often find myself browsing through the scheduled program and finding one or more presentations on the magic circle. If you've ever been to an academic game gathering, you know the kind of talk. They are generally given by earnest graduate students, and have titles like "Beyond the Magic Circle," or "The Pitfalls of the Magic Circle." A few years ago, there was an entire conference called "Breaking the Magic Circle."

Invariably, these presentations have a single aim: to devalue, dethrone, or otherwise take down the oppressive regime of the magic circle. They begin by citing either Johannes Huizinga's *Homo Ludens* or *Rules of Play* (the game design textbook I co-authored with Katie Salen), and then elaborate mightily on the dangers of the magic circle approach. They proceed to supplant the narrow magic circle point of view with one of their own—an approach that emphasizes something like social interaction between players, a wider cultural context, or concrete sociopolitical reality. Dragon slain.

I regularly get emails from budding game critics asking me if I think the magic circle "really ultimately truly" does actually exist. It seems to have become a rite of passage for game studies scholars: somewhere between a Bachelor's Degree and a Master's thesis, everyone has to write the paper where the magic circle finally gets what it deserves.

We all know it's fun to take down an authority figure. But what I want to ask here is: what is this oppressive regime that these well-intentioned researchers feel a need to overthrow? Who is this Voldemort that these papers dangerously invoke, in order to stage a final battle of good against evil? Does anyone really hold to the orthodox, narrow view of the magic circle, or is the phenomenon of taking down the magic circle just game studies scholars tilting at windmills?

## **The Magic Circle Jerk**

The problem runs deep. It goes beyond just wide-eyed graduate students. Sometimes, I see it in the work of colleagues for whom I have the utmost respect and whose work I otherwise admire: game studies icons Mia Consolvo, Marinka Copier, and T.L. Taylor all have written about the need to overthrow the oppressive magic circle.

The argument goes something like this: the idea of magic circle is the idea that games are formal structures wholly and completely separate from ordinary life. The magic circle naively champions the preexisting rules of a game, and ignores the fact that games are lived experiences, that games are actually played by human beings in some kind of real social and cultural context.

My question remains: who is this ignoramus that holds these strange and narrow ideas about games? Where are the books and essays that this formalist-structuralist-ludologist has published? Where is this frightfully naïve thinker who is putting game studies at risk by poisoning the minds of impressionable students? Just who is this magic circle jerk? (Note that the word is "jerk" as in *annoying person*—I'm using it as a noun, not a verb.)

I am here to tell you: there is no magic circle jerk. We need to stop chasing this phantasm. I offer this essay as a corrective. It is meant to clarify where this magic circle idea came from, what it was intended to mean, and to stop the energy being wasted by chasing the ghost of the magic circle jerk—a ghost that simply doesn't exist.

### Birthing a Straw Man

Perhaps I'm sensitive to the phenomenon of the magic circle jerk because I (or Katie Salen and I) often are identified as the embodiment of the worst of the magic circle. In fact, game designer Frank Lantz and I started using the term in our game design classes years before work on *Rules of Play* began. In 1999, we co-authored an article for Merge Magazine called Rules, Play, Culture: Checkmate that referred to the magic circle as "the artificial context of a game... the shared space of play created by its rules."

However, the term only reached full fruition in *Rules of Play*. It's certainly true that in the nearly 10 years since the book was published, the idea of the magic circle is easily the most popular concept to come out of it. So in many ways I do feel responsible for the magic circle shenanigans that have followed the book's publication.

Where does it come from? Frank and I first read the phrase "magic circle" in Huizinga's *Homo Ludens*, where it appears a scant handful of times—once each on pages 10, 11, 20, 77, 210, and 212 (of the 1972 Beacon Edition). Its most prominent and oft-cited mention is in this paragraph on page 10:

All play moves and has its being within a play-ground marked off beforehand either materially or ideally, deliberately or as a matter of course. Just as there is no formal difference between play and ritual, so the "consecrated spot" cannot be formally distinguished from the play-ground. The arena, the card-table, the magic circle, the temple, the stage, the screen, the tennis court, the court of justice, etc., are all in form and function play-grounds, i.e. forbidden spots, isolated, hedged round, hallowed, within which special rules obtain. All are temporary worlds within the ordinary world, dedicated to the performance of an act apart.

Here "magic circle" appears in a list of phenomena that includes game spaces (card table, tennis court), spaces for art and entertainment (stage, screen), and even "real-world" spaces (temple, court of justice). The magic circle is yet another example of a ritual space that creates for Huizinga a "temporary world within the ordinary world, dedicated to the performance of an act apart."

The "magic circle" is not a particularly prominent phrase in *Homo Ludens*, and although Huizinga certainly advocates the idea that games can be understood as separate from everyday life, he never takes the full-blown magic circle jerk point of view that games are ultimately separate from everything else in life or that rules are the sole fundamental unit of games. In fact, Huizinga's thesis is much more ambivalent on these issues and he actually closes his seminal book with a passionate argument against a strict separation between life and games.

The magic circle is not something that comes wholly from Huizinga. To be perfectly honest, Katie and I more or less invented the concept, inheriting its use from my work with Frank, cobbling together ideas from Huizinga and Caillois, clarifying key elements that were important for our book, and reframing it in terms of semiotics and design—two disciplines that certainly lie outside the realm of Huizinga's own scholarly work. But that is what scholarship often is—sampling and remixing ideas in order to come to a new synthesis.

Game Studies eminence Espen Aarseth made a similar point about the origin of the magic circle in a discussion after his presentation *Ludus Revisited: The Ideology of Pure Play in Contemporary Video*

Game Research at the most recent DiGRA conference. According to Espen, after trying and failing to locate the idea inside *Homo Ludens*, he had decided Katie and I should be blamed for the concept, and everyone should just let Huizinga off the hook.

### The Importance of a Viewpoint

The brilliant designer and renowned MMO scholar Richard Bartle made a stink at a game conference several years ago by interrogating many of the presenters (most of whom were not game creators) about their research. After their talks, one by one, he asked them: "But how will your research help me make a better game?"

Now I, more than anyone, enjoy cantankerous outbursts, but Richard's repeated question was ultimately misplaced. You can't expect every research paper to address everyone else's disciplinary needs. In the end, it should be up to Richard to figure out if and how someone's research might help him make a better game, just as it was up to the historians, psychologists, and other researchers at the conference to decide if and how the design presentations from Richard (and myself) helped them with their work.

*Rules of Play* is a book about game design, and it was written to help game designers better understand what it means to create board and card games, social and physical games, and—of course—video games. In considering and critiquing ideas from the book, it is important to remember the disciplinary point of view from which it was written.

For example, if you read *Rules of Play* as a sociologist, the book is never going to possess a sociological standpoint as subtle and nuanced as an actual work of sociology. *Rules of Play* is not filled with research and footnotes from the history of sociological work, and its concepts do not build carefully on those from the well-heeled discipline of sociology.

The same is true when I read something through my own disciplinary lens as a game designer. I don't expect sociologists, or media studies scholars, or economists to have ingested and assimilated the whole of game design theory before they begin their work. I certainly can critique their research, but I would do so with an understanding of how their own disciplinary point of view differs from mine.

Just to clarify: I am not saying that one can't speak to issues and individuals outside of a home discipline. On the contrary, I so often find myself inspired by scholarly work outside of game design, just as I am constantly inspired by art, entertainment, and media that doesn't take the form of games. But as a practicing game designer I know that I myself must bridge the gap between these works and my own interests and goals.

Concepts and ideas should be understood within the framework of their originating discipline. This seems like an incredibly straightforward point, but critiques of the magic circle often point out how *Homo Ludens* or *Rules of Play* fails to present a concept as it should be understood within the discipline of the author. For example, just the aroma of the idea that game rules might be considered as divorced from a social reality has been enough to send many a game studies social scientist into a magic circle frenzy.

This is all complicated by the fact that game studies scholars are working in a radically interdisciplinary space, where ideas and fields mix freely. This only increases our need to be cognizant of our differences. Often, for example, we share and exchange concepts, but our methodologies and the aims of our research are wildly divergent. These differences are productive, but can be the source for misunderstandings. The phenomenon of the magic circle jerk is a case in point.

### The Magic Circle as a Concept for Game Design

*Rules of Play* is a book about game design. Every concept between its covers was conceived as something useful for designers struggling with the process of creating games—useful for generating concepts, for constructing games, for analyzing designs. *Rules of Play* emphasizes how games create meaning, by being or becoming contexts in which meaning gets made.

Within this larger set of ideas, the magic circle is a fairly simple concept. It is a term that reminds us how meaning happens. Imagine, if you will, coming to visit me in my Brooklyn apartment. The two of

us chat over coffee, as a Chess set sits nearby. Consider the web of relations between you and I and the Chess set as we sit and talk. Perhaps the figurines on the Chess board serve as a conversation starter, or perhaps as a social marker that I am a game player, or maybe they are just part of the aesthetic décor of my living room. Or—most likely—all of these and many more.

Once we start playing a game of Chess, many of these relationships shift and change. For example, in a casual conversation, we might fiddle with the Chess pieces on the board, knocking them about. But after we begin to play, suddenly it really matters whether a piece is in the middle of a square or not, and which of us can move it, and when, and how. Each of our kings acquires a special significance, and our social interaction shifts—perhaps it becomes more adversarial, or more conversational, or simply more quiet. Time and space, and identity, and social relations acquire new meanings while the game is going on. This is how playing a game is "entering a magic circle"—there are meanings which emerge as cause and effect of the game as it is played.

For me this idea—that games are a context from which meaning can emerge—is so simple as to be almost banal. Hardly a cause for debate! And note that this general understanding of the magic circle does not imply the impossibly brittle, heavy-handed caricature that is so often criticized—the ideas held by the imaginary magic circle jerk.

For example, are the meanings that emerge from the Chess game in my example completely divorced from ordinary life? Absolutely not! They are inexorably intertwined. A preexisting friendship, for example, will certainly impact the social interaction between players in a game. Are the meanings ultimately derived from the rules and formal structures of the game? Hardly! Meaning is everywhere and infinitely subtle, appearing wherever one wishes to look. Certainly there are game-meanings that are tied to the rules of the game, but there's no reason to assume that those elements always dominate over others.

In fact, there's no need to think about the magic circle (a context for meaning creation) as something exclusive to games. Could one think of almost any physical or social space as a magic circle in this way? Probably—if that's your cup of tea, go for it. Certainly Huizinga makes a similar gesture when he places courts of law and religious temples in the same "play-ground" category as card tables and tennis courts.

Critiques of the magic circle often hinge on identifying in *Rules of Play* a subtle emphasis on the designed elements of games, rather than on more purely sociocultural phenomena. Critiquers, I have good news for you: you are correct. *Rules of Play* does tend to emphasize the meanings that are tied to the elements that designers actually create. Why? Because it is a book written by and for designers.

As a book about game design it has a special interest in the *actual construction* of games—the rules and materials, the systems and code that game designers create, and the way that those elements impact player experience. But the book certainly also spends an extensive amount of time detailing the contextual aspects of games—for example, one of the four sections of the book is entirely dedicated to thinking about the cultural contexts of games.

*Rules of Play* was written by designers. Understanding our disciplinary point of view can help explain why we might be interested in the meanings that are formed in part from the decisions of designers. However, there is a world of difference between a subtle emphasis on design and the ham-fisted hyper-structuralism of the mythical magic circle jerk.

## Thinking Many Ways at Once

I recently visited a game studies class. Throughout the discussion after my talk, the professor peppered me with questions about the magic circle: *Can we REALLY look at rules in and of themselves? Is it truly possible to separate rules from the rest of games? And why would we even want to?* He addressed me as if I was the very embodiment of the magic circle jerk, manifesting right there in his classroom. Before I could convince him (and the class) that nobody really held any of the ideas he wanted to question, I first had to convince him that I wasn't really the enemy that he thought I was. It was certainly an out-of-body kind of experience.

One of the most basic ideas in *Rules of Play* is that we can look at games from multiple and contradictory points of view. And furthermore: that this is the right and proper thing to do with such a complex phenomena as games. As Katie and I write in *Rules of Play*, most of the chapters represent a "schema"—a particular lens that can be used to focus on certain aspects of games.

We organize them into three general types—*formal* schema focused on rules (i.e., games as systems of uncertainty or as cybernetic feedback loops), *experiential* schema focused on play (games as social play or as the play of desire), and *cultural* schema focused on context (games as cultural rhetoric or as ideological resistance). This is the same thing as saying that literature can be understood as the rhythms of style, or as the representation of gender and class, or as the history of the printing press—or as any number of things.

When we use one schema to understand, analyze, or design games, other schemas may need to be ignored or repressed. There are, for example, key mathematical aspects of games that are crucial for learning the craft of game design, such as calculating basic probability or understanding game theory functions. Focusing on the math in making a game (such using a spreadsheet to juggle the relative experience point level-up curves of different classes in an RPG) might mean temporarily suspending a critical awareness of (for example) the sociocultural identity of the player base.

However, eventually the RPG designer would need to connect the pure math to the game's play and to its culture. A level-up experience point curve implies a certain tempo of play advancement relative to a reward/frustration pattern of desire. And the shape of this play is certainly something that should be designed relative to an understanding of a particular kind of player's expectations and assumptions—aspects of player attitudes that are closely tied to sociocultural identity. In other words, the math bone is connected to the culture bone. All of the schemas in *Rules of Play* really are ultimately intertwined, even if sometimes we have to separate them to see one aspect of games more clearly.

Applying different cognitive frames to knowledge at different moments is part of any intellectual or creative pursuit. A violinist in the midst of performing a Rochmananov cadenza is not going to simultaneously ponder the biography of the composer of the piece she is playing at that very moment. However, during her rehearsal period, that kind of research is certainly something that may have informed her musical practice.

I have always thought that the multiple-schema approach of *Rules of Play* offers an *antidote* to a narrow, rules-centric approach—the approach of the magic circle jerk. The aggravating irony is that this is exactly the brush we get tarred with! Jesper Juul captures this bizarro-world logic in his essay The Magic Circle and the Puzzle Piece: "...theorists also claim to counter Huizinga, Salen, and Zimmerman by stressing the exact social nature of the magic circle that Huizinga, Salen, and Zimmerman also stress." Let's stop the insanity.

## Design Isn't Science

As a designer, I am an avowed relativist. For me, the value of a concept is not its scientific, objective truth. The value of a concept is its utility to solve problems as they are encountered in the design process. The concepts in *Rules of Play* are not meant to explain or define games once and for all. They are tools that can be used to understand, construct, and modify games. As MIT pioneer Marvin Minsky put it, a concept is a "thing to thing with"—not a law that points towards a truth.

This is why designers must embrace the deliciousness of contradiction. For example, to solve the feedback loop problems in your game's victory conditions, you might need to take off your media studies hat for a moment. Or to understand why all of your playtesters despise your game's main character, you might need to cease your formalist system-tweaking and consider instead the narrative politics of gender representation at work in your game.

One concept-tool might be completely useless for solving one particular problem, but crucial for something else. Thinking of games in all of their complexity as math, aesthetics, desire, social experience, gender, story, identity, etc.—this is what game design is all about. Interpretive schema can violently contradict each other! But that's absolutely the way it should be.

Many approaches to the study of games operate under a more scientific model—the idea that there are truths about games, and it is important to discover these truths and establish an accurate picture of what games actually are and how they really operate. I welcome others who want to hanker after scientificity, but such concerns do not motivate my own thinking about games. Just to restate: in my opinion, for a designer the value of a concept is its utility, not its ultimate truth. And concepts like the magic circle that come out of *Rules of Play* reflect this non-scientific designer's approach.

I believe this is why I often see presentations or read papers asking whether the magic circle really—ultimately—finally does or doesn't exist. The answer, as far as I am concerned, is *yes and no*. It just depends on what you are trying to understand about games, and why you are making use of the concept. If you want to look at games as a pure mathematician, or a strict ludologist, it makes perfect sense that you might adopt a more closed idea of games-as-rules. If you are a social anthropologist, then such a closed view wouldn't have much use in solving your research questions.

There is nothing wrong with temporarily adopting a limited point of view, as long as you're aware of the limitations of the blinders you are putting on. In fact, this is what research in an interdisciplinary field is all about! Understanding the limitations in our own points of view can help us in our understanding of each other.

Now you may be thinking... Aha! Articulating limitations—that's the problem! Those darn magic circle jerks don't do enough to describe the blinders they are putting on. They don't sufficiently make the limitations of their limited perspective known! I want to remind you that *there is no magic circle jerk*. This naïve character—the ultimate hardcore formalist—is a phantasm. Nobody in game studies, as far I know, is taking that point of view seriously. The entire purpose of my essay is to point out that this magic circle jerk is a fiction that people project onto *Homo Ludens* and *Rules of Play*.

## Play On

I have made a harsh caricature of the magic circle jerk—as a silly super-structuralist that dogmatically believes in the truth of a hard-edged magic circle. Perhaps I have replaced the myth of the magic circle with a myth of my own—the impossibly idiotic magic circle jerk. But is it possible that the ghost of the jerk remains somewhere, as a tendency, as a predilection, as a potential that can still poison game studies?

In his excellent essay *The Magic Circle and the Puzzle Piece* (from which I quoted earlier), Jesper Juul echoes many of the ideas I have put forth here: that there has been a wave of criticisms against the magic circle, and that they stem from a misunderstanding about the concept as presented in *Homo Ludens* and *Rules of Play*.

One of Jesper's ideas is that the criticism of the magic circle is a symptom of "binary thinking"—an intellectual sensibility that seeks to identify and then overthrow theoretical dualities. The magic circle, according to Jesper, represents a particularly ripe binarism to tear down, because it (or rather, its misunderstood caricature) is the idea of a hard binary separation between what is inside and what is outside a game.

I agree with Jesper. My own feeling is that the impulse to overthrow such binarisms is a residue of the critical sensibility that dominated the '90s—the era of deconstruction and poststructuralism in which many game studies scholars came of age. The instinct to exaggerate the dangers of the magic circle so that it can be valiently deconstructed is linked to the notion that ideas are most authentic when they tear down an authority—even if the authority is no more than a highly concocted, imaginary effigy. Or, let me put it in another, less diplomatic way: propping up invented straw men just so you can knock them over is a lazy way to do research.

A final thought. You are probably reading this essay because you love games. Perhaps you love to play them, to study them, to create them—or some combination of all three. It is amazing that we can cross radical disciplinary boundaries, accept our differences across concepts, methods, and aims, yet still be united in our polyamorous and unabashed love for games. This love that embraces contradiction is beautiful. It has many names, but I like to call it *play*.

Let's play together. And put to bed this magic circle jerk once and for all.

## **Summary: Myths of the Magic Circle Debunked**

1. Nobody actually holds the orthodox view of the magic circle. There is no circle jerk behind the curtain.
2. While it was based on a passing term Frank Lantz and I noticed in *Homo Ludens*, Katie Salen and I more or less introduced the concept of the magic circle as it is used today. Blame us for all the trouble, not Huizinga.
3. Keep in mind the discipline from which a work or idea originated. Don't dismiss concepts in one field of knowledge because it doesn't fit your own discipline. The onus is on each of us to translate ideas from the outside into our own areas.
4. The magic circle, as put forward in *Rules of Play*, is the relatively simple idea that when a game is being played, new meanings are generated. These meanings mix elements intrinsic to the game and elements outside the game.
5. In my opinion, design concepts (such as the magic circle as described in *Rules of Play*) derive their value from their utility to solve problems. Their value is not derived from their scientific accuracy or proximity to truth.
6. Looking at a complex phenomena like games from many points of view, it is important to embrace contradiction. The magic circle can be thought of as open or closed, depending on why you are making use of the concept.
7. The magic circle jerk *doesn't exist*. Nobody really takes the hard line that everyone wants to criticize. I'm sick of the magic circle jerk. Let's bury the bastard.

## **Notes**

Because I didn't want to make this an angry and defensive finger-pointing rant, you may have noticed that I never actually cited any evidence for the magic circle jerk. There are no embarrassing quotes from papers or presentations attacking the magic circle. Although this lack of footnotes certainly relegates this essay to mere pseudo-scholarship, I am assuming that the phenomenon I describe is so pervasive that actual references just aren't necessary. (If you must dig deeper, a good place to start is Jesper's essay *The Magic Circle and the Puzzle Piece*.)

Regarding Espen Aarseth's comments about letting Huizinga off the hook, he later told me his comments had been influenced by Gordon Calleja's essay *Erasing the Magic Circle*—to be published in an upcoming issue of *The Philosophy of Computer Games*.

This essay was written solely from my own point of view, and does not represent the ideas of Katie Salen, my amazing *Rules of Play* co-author. I sometimes included her name to make sure that she was credited with the core ideas and concepts we wrote together. But she may well have a very different perspective on this magic circle business than I do. *Vive la différence!* And same goes for my game design hero Frank Lantz, with whom I originally encountered the work of Huizinga.

Special thanks to insightfulness engines Jesper Juul and John Sharp for their feedback and editing. Also big thanks to Gamasutra and to Christian Nutt for additional feedback.

PS: I love you, Richard Bartle! Promise you'll never stop being you.

## **Symposia**



# **Formal Game-Based Assessments: The challenge and opportunity of building next generation assessments**

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**Abstract:** National and global initiatives are starting to put pressure on testing systems and companies to change how learning is being measured. As a result, testing companies have begun turning to digital media as possible solutions for next generation assessments. While testing companies may be under pressure to change, the need for rethinking how we approach measuring learning involves a much greater shift than simply putting assessments “on line.” It requires a framework that combines attributes from both game and assessment design. This paper will discuss the tensions between principles of good game-design and assessment design. We offer design insights and a suggested framework for designing/developing game-based assessments grounded in two case studies. Case 1 illustrates the tension between principles of good game design and what is required of assessments. Case 2 illustrates how some of the principles of good game design can actually be applied to assessment frameworks.

## **Introduction**

*One thing I never want to see happen is schools that are just teaching the test because then you're not learning about the world, you're not learning about different cultures, you're not learning about science, you're not learning about math. All you're learning about is how to fill out a little bubble on an exam and little tricks that you need to do in order to take a test and that's not going to make education interesting.*

President Barack Obama, March 28, 2010

We are in a unique time where a confluence of events is creating the opportunity to re-think what it means to assess learning in the 21<sup>st</sup> century. National and global initiatives are starting to put pressure on testing systems and companies to change how learning is being measured (e.g. Race to the Top, Cisco, Intel and Microsoft’s Assessment and Teaching of 21<sup>st</sup> Century Skills, development of new Common Core State Standards). As a result, testing companies have begun turning to digital media as possible solutions for next generation assessments. Many assessment organizations are creating pipelines to integrate digital game and new media designers and developers into this space—inviting digital media designers and learning scientists to sit on advisory boards, hiring game designers to explore the possibilities of using game-based assessments, and holding meetings on the future of assessment with a wide variety of stakeholders. However, while testing companies may be under pressure to change, the need for rethinking how we measure student learning involves a much greater shift than simply putting assessments “on line.” It requires a framework that combines attributes from both game-design and assessment design. In this symposium, we will discuss the tensions between principles of good game-design (e.g. Gee, 2003; 2011) and assessment design (e.g. ECD, Mislevy, Steinburg, Almond, 2003). In doing so, we will offer design insights and a suggested framework for designing/developing game-based assessments that is grounded in two case studies: (1) the Learning Games Network’s collaboration with ETS on developing game-based assessments and (2) efforts to design assessments using digital media in the Virtual Performance Assessment Project. In the following sections we briefly present the background context for our research, discuss an assessment framework, introduce the cases, and then conclude with the discussion of design principles.

## **Background**

While there have been efforts to change standardized assessment programs in the past, they did not have the financial or policy-level support that is driving current initiatives. For example, efforts to use alternate assessment approaches such as performance-based measures for science (Linn, 1994), performance-based technology assessments (Baxter, 1995; Baxter and Shavelson, 1994; Pine, Baxter, Shavelson, 1993; Shavelson, Baxter, Pine, 1991; Rosenquist, Shavelson, Ruiz-Primo, 2000), and portfolios (Koretz, Stecher, Klein, & McCaffrey, 1994) were not robust enough to replace current

testing programs due to their inability to compete with the reliability, scalability, and cost-effectiveness of multiple-choice and open-response approaches (Cronbach, Linn, Brennan, & Haertel, 1997; Shavelson, Ruiz-Primo, & Wiley, 1999). Two additional reasons for why previous efforts did not work are due to the fact that (1) the design teams were not comprised of teams containing: designers, psychologists, content specialists, and measurement specialists (either one or more were missing) and (2) not enough time was spent piloting items (NRC, 2010). While research has shown that multiple-choice and open-response tests are not good measures of higher-order thinking and cognitive skills (Resnick & Resnick, 1992; Quellmalz & Haertel, 2004), they have remained the default approach. However, advances in the learning sciences, technology/digital media, and measurement models over the past decade set the context for exciting opportunities for developing next generation assessments. We briefly discuss some of them below.

## Data Capturing & Learning Analytics

Digital games and media allow for the capturing of data and observations of student learning that are not possible via multiple-choice and paper-based tests. As students interact with the digital environment, their actions can be captured via log data. These data can be utilized to explore learning trajectories, processes, and attempts at problem solving. Analysis of log data can provide more insight on learning by providing information on what led to incorrect as well as correct answers. Research on learning analytics is an emerging field and has gained increasing attention in the last several years, with initial endeavors in this space showing much promise (e.g. Baker, 2009; Roll, Aleven, Koedinger, 2010, Shute, 2011; Sao Pedro, Baker, Gobert, Montalvo, & Nakama, 2011; Shute, Masduki, Donmez, 2010). Next generation assessments will allow us to think differently about data and the kinds of algorithms used to model learning.

## Assessment Design Frameworks

Over the past decade, researchers have made significant advances in methods of assessment design. Frameworks such as Evidence-Centered Design ([ECD] Mislevy et. al. 2003; Mislevy & Haertel, 2006) provide rigorous procedures for linking theories of learning and knowing to demonstrations to interpretation. ECD is a comprehensive framework that contains four stages of design: domain analysis, domain modeling, conceptual assessment framework and compilation, and four-phase delivery architecture. Phases 1 and 2 focus on the purposes of the assessment, nature of knowing, and structures for observing and organizing knowledge. In Phase 3, assessment designers focus on the student model (what skills are being assessed), the evidence model (what in-world interactions elicit the knowledge and skills being assessed), and the task model (situations that elicit the behaviors/evidence). These aspects of the design are inter-related. In the compilation phase, tasks are created. The purpose is to develop models for schema-based task authoring and developing protocols for fitting and estimation of psychometric models. Phase 4 of the delivery architecture, focuses on the presentation and scoring of the task. While the popularity of using ECD has increased, most projects developing assessments using digital media have adapted the framework to assess interactions and trajectories (e.g. Shute & Torres, 2011; Clarke-Midura, Code, Zap, & Dede, 2012, Rupp, Gushta, Mislevy, & Shaffer, 2010). As we will show in this paper, it is important to find a framework that incorporates affordances of both game design and assessment design.

## Case 1: ETS and LGN

In the summer of 2011, the US Educational Testing Service (ETS) partnered with the Learning Games Network (LGN) to collaborate on the development of new testing modules that were designed from a digital games approach. The partnership was sought to purposefully experiment in this space and explore a new opportunity of developing testing scenarios. Ultimately, the collaboration surfaced a very real tension, and an innate opportunity:

*There is a considerable and fundamental difference between learning games and assessment ‘games’—yet much of this chasm is result of the vastly different paradigms these groups work from, and given the right space and support to explore this interdisciplinary work, real opportunity for innovation exists.*

From this work, it was very clear to us that this is most certainly an emerging space, and the entire field of assessment is just starting to figure out this nexus. We knew coming into the work there was a big difference between games and summative assessment, and we knew there would be some losses on both ends, but both groups acknowledged they greatly underestimated just how much that

challenge has been. The fundamental tension that emerged is that many games try to create a context that instills learning first, but that is not a goal in assessment—in fact, it's the exact opposite, formal assessment designers do not want the experience to instill anything because they want a baseline appraisal of the students knowledge and ability. Yet, we believe this tension does not mean there isn't an opportunity and possibility in this nexus. Rather, we see the challenge as being both groups coming from very different positions—which must be mitigated first in order to find the ripe opportunity in that nexus. Most certainly interdisciplinary work, our reflections align with suggestions from the research on successful interdisciplinary collaborations: both of these groups have found that when starting a new collaboration with non-traditional partners (Boix Mansilla, 2006), there is a phase of vocab reconciliation, where it takes time, space and the work itself to allow these two camps to get on the same page.

The ETS-LGN collaborated produced several fruitful artifacts based on various game designs and dynamics, including RPG models, which subsequently have been developed and adopted into national testing frameworks. However, more critically, it elucidated the critical areas to be worked through in order to achieve prosperous innovation at this nexus. What is needed is a focused workshop effort where interdisciplinary participants *create together* a shared vocabulary and understanding about each other's perspectives and needs in the design process.

## **Case 2: Virtual Assessment Project**

The Virtual Performance Assessment project at the Harvard Graduate School of Education is developing and studying the feasibility of immersive virtual performance assessments (VPAs) to assess scientific inquiry of middle school students as a standardized component of an accountability program (see <http://vpa.gse.harvard.edu>). The goal of the research is to provide the field with working examples of reliable and valid technology-based performance assessments linked to state and national academic standards for science content and inquiry processes.

The virtual performance assessments are designed in the Unity game development engine (Unity Technologies, 2010). The immersive nature of the three-dimensional (3D) environment allows for the creation and measurement of authentic, situated performances that are characteristic of how students conduct inquiry (NRC, 2000). Students have the ability to walk around the environment, make observations, gather data, and solve a scientific problem in a context. Further, these environments enable the automated, invisible, and non-intrusive collection of students' actions and behaviors during the assessment play. These data allow us to build rich trajectories of student performance.

## **VPA Design Framework**

In order to ensure that the assessments measure what we intended them to measure (inquiry), we used a modified version of the Evidence Centered Design (ECD) framework (Mislevy & Haertel, 2006; Mislevy & Rahman, 2009) to design the assessments (see Table 2 below). Using the ECD approach allowed us to articulate every aspect of the assessment from the knowledge, skills, and abilities (KSAs) that they are measuring to the types of evidence that will allow one to make claims about what students know. Using this framework, we have reframed science inquiry constructs (theorizing, questioning and hypothesizing, investigating, analyzing and synthesizing) into specific (KSAs) aligned with current national standards. Through the process of articulating the exact details of what is being measured and how it is being measured, it is easy to link the KSAs to evidence of student learning. Linking KSAs like this provides a measure of validity that research has found often lacking in performance assessments (e.g. Linn, Baker, & Dunbar, 1991).

The skills we are measuring in this particular VPA focus on gathering data around a claim, making a claim, and supporting it with evidence and reasoning—skills that we argue are difficult to capture in multiple choice and open response tests. By setting up the assessment in a game-based environment, we can follow students' trajectories of data gathering. We then can correlate their interactions to the claims they build and the evidence and reasoning they use to support those assertions. Each challenge in our assessments relies on students collecting data and providing evidence to support a claim, and students' scores are based on the evidence and reasoning they provide for a given claim.

Traditional assessments often focus on individual test items and rely on student affirmation as a response that indicates knowledge. In the VPAs, the evaluation of student performance is based on measurements captured as in-world interactions. These interactions allow us to assess what students

know and do not know about science inquiry and problem solving. The series of interactions result in rich observations that enable us to make a fine distinction of students' understanding of the various facets of inquiry. Designing for interactions involves providing experiences for students that not only model how a scientist conducts science but also provide opportunities for learning and feedback on learning. Existing paper-based models for assessing science are not able to model the complexity of science practices and processes. See figures 1 and 2 below for images of the assessment.



**Figures 1 & 2: Screenshots of the Virtual Assessments.**

As seen in the images above, our assessment has the look and feel of a videogame, yet places students at the center of a scientific problem that they have to solve. Thus, our attempt is develop assessments that measure students' science learning *in situ*.

### Next Generation Design Framework

Lessons learned from our cases are that the principles we apply to good game design involve play as learning and learning from play. However, when using games for assessment, play becomes performance and we need to think about performance as play and demonstration of learning (Clarke-Midura, *in press*). Various traits of effective learning games have been proposed in the literature (Osterweil & Klopfer, 2011; Gee, 2011; Gee, 2005, which we have synthesized into a list of dimension of characteristics of good learning games:

<b>Dimensions of Characteristics of Learning Games</b>	
1. Freedom to Fail	
2. Freedom to Experiment	
3. Freedom of Identity	
4. Freedom of Effort	
5. Narrative	
6. Agency	
7. Interaction	
8. Well-ordered problems	
9. Clear goals	
10. Copious feedback	
11. Customization	
12. Well-designed experiences	
13. "Pleasantly Frustrating"	
14. Mentoring in game and meta-game	
15. Performance before competence	
16. Cycle of Expertise	
17. Smart tools	
18. Non-linear learning	
19. Distributed knowledge	
20. Information just-in-time and on demand	
21. Model-based and system thinking	
22. Production and innovation	

**Table 1: Dimensions of characteristics of good learning games.**

These traits often appear in good learning games, to varying degrees—which is why we emphasize the ‘dimensional’ aspect to these characteristics; however they are often observed in a good learning game as they embody a distinct pedagogical approach. The first case study, LGN and ETS, will illustrate the tension between what we agree are principles of good game design and what is required of assessments. In the second case study, VPA, we illustrate how some of the principles of good game design can actually be applied during the compilation phase of ECD, when designing the tasks and interactions. It is important to start with the knowledge, skills, and abilities you want to measure and then work backwards to come up with examples of evidence. How do you know that a student has demonstrated a particular knowledge or skill? ECD forces you to think through the kinds of performances or interactions that provide evidence that a student knows or understands a skill. We refer to this as performance as play. Take aspects of play and good game design and turn them into *performances of knowing*. Table 2 below presents the integration of Gee’s principles with the ECD framework.

<b>Modified ECD framework</b>	<b>Description</b>
I. Domain Analysis	<ul style="list-style-type: none"> <li>• Develop purpose for assessment.</li> <li>• Develop definition of competence.</li> <li>• Consult experts in the fields about our chosen definitions.</li> </ul>
II. Domain Modeling	<ul style="list-style-type: none"> <li>• Use information from the domain analysis to establish relationships among proficiencies, tasks, and evidence.</li> <li>• Develop high-level sketches that are consistent with what they have learned about the domain so far.</li> <li>• Create graphic representations and schema to convey these complex relationships, and develop prototypes.</li> </ul>
III. Conceptual Assessment Framework: <ul style="list-style-type: none"> <li>• Student Model</li> <li>• Observation/Tasks Model</li> <li>• Interpretation/Evidence Model</li> </ul>	<p><i>Student model:</i> What complex of knowledge, skills, or other abilities should be assessed.</p> <p><i>Observations/Tasks:</i> Identify kinds of tasks or situations (interactions) that will prompt students to say, do, or create something that demonstrates important knowledge, skills, and competencies.</p> <p><i>Evidence:</i> Identify behaviors and performances that reveal knowledge and skill identified in the student model. Identify and summarize evidence.</p>
IV. Compilation: <ul style="list-style-type: none"> <li>• Task creation</li> <li>• Statistical Assembly</li> <li>• Assessment Implementation</li> </ul>	<p>Develop tasks based on conceptual assessment framework that include characteristics of good game design.</p> <ul style="list-style-type: none"> <li>• Problem-solving</li> <li>• Clear goals</li> <li>• Well-designed experiences</li> <li>• Well-ordered problems</li> <li>• Smart tools</li> <li>• Information just-in-time and on demand</li> <li>• Model-based and system thinking</li> </ul> <p>Develop models for evidence. Develop statistical assembly and strategies and algorithms for test construction.</p>
V. Four-Process Delivery Architecture: <ul style="list-style-type: none"> <li>• Presentation</li> <li>• Response Scoring</li> <li>• Summary Scoring</li> <li>• Activity Selection</li> </ul>	<p>Develop data structures and processes for implementing assessments.</p> <p>Develop back-end architecture that will capture and score student data.</p> <p>Develop prototype. Pilot.</p>
VI. Refinement	Refine assessment based on pilot data. Iterative cycle.

**Table 2: Modified Evidence Centered Design Framework.**

## Conclusion

The need and demand for richer forms of data about student learning and ability has never been greater; at the same time, never has the energy and evidence of the opportunity of learning games. Many state, national, and international testing companies are starting to transition to technology for delivering and administering assessments. While numerous initiatives exist for promoting change and innovation in current assessment systems, it is important that we learn from historical attempts at changing assessment. Digital media and game-based assessments offer potential to design innovative approaches for measuring learning and providing observations that are not possible with

multiple-choice and open-response tests. Next generation assessments require a collaborative team of designers with expertise in measurement, content, learning & cognition, and design of digital media/games.

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# Using Working Examples to Bridge Research and Practice with Digital Media and Learning

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**Abstract:** This panel joins K-12 and higher education researchers and practitioners demonstrating “working examples” as a new form of scholarship informing research and practice. Together their presentations illustrate the successes and failures of current research-based digital media initiatives in school. Drawing on theory, and grounded in concrete instances, authentic examples are presented as a means of creating an interdisciplinary “participatory culture” (Jenkins et al., 2006) around digital media and learning (DMAL). Revealing, and then discussing, the complicated task of moving from research to practice with DMAL opportunities proposes a collaborative approach serving to further expertise. Recognizing the changing definition of literacy, fueled by practices with technology, necessitates rethinking traditional beliefs around schooling and *scholarship* serves as the backdrop for this conversation.

## Introduction

Traditional forms of scholarship and publication around new media and learning, while theoretically plausible, often fail to translate into meaningful transformations within educational practice. Complicating the ineffective or absent interpretation of research impacting practice, is a current generation of academics and practitioners experiencing an historical shift in methods and modalities for communicating and building understanding. Social media and emerging technologies shift the definition of literacy and relocate expertise (Fahser-Herro & Steinkuehler, 2010), suggesting the future of literacy and scholarship will ultimately be influenced by acceptance of what Gee (1996) refers to as Discourses—socially recognized ways of using language to construct meaning inclusive of gestures, semiotics, and thinking—and through modes, logics, and affordances influenced by screen and image (Kress, 2003). These new literacy practices and ways of knowing will be influenced by participatory cultures being formed online in shared spaces. Cultures of participation support meaningful creations and contributions in socially-connected spaces, often facilitating informal mentorships between experts and novices (Jenkins, Clinton, Purushotma, Robison, & Weigel, 2006). The shifting definition of literacy, its impact on knowledge creation, dissemination and understanding, and the desire to move forward in the field of digital media and learning (DMAL) compels educational researchers to consider the impact of participatory cultures on *scholarship*.

In response, the call to transcend typical print-based and centrally controlled forms of scholarship in DMAL, a new invitational form of scholarship, “worked examples” or “working examples” is emerging as a way to solve well-known problems, advance generalizations and reveal reasoning via authentic illustrations (Gee, 2009). Purposefully this panel poses, “working examples” affirming the in-progress nature of their work. This model of scholarship joins various theorists, disciplines, and approaches illuminating or “working through” explicit, multimodal examples in an effort to provide context, advance collaborative discussion and further the potential for ongoing work. These examples of authenticity purposefully select instances, data, descriptions, and design to describe, discuss, and advance scholarly understanding (Barab, Dodge & Gee, n.d.).

With the goal of facilitating collaborative, participatory discourse and sense-making regarding the feasibility of incorporating worthwhile game environments within educational practice, this panel brings together K-12 and higher education practitioners and scholars utilizing authentic working examples to illuminate the “thinking, practices and values of a discipline overt and public for newcomers” (Gee, n.d.). Together they share the theoretical underpinnings, design, process, barriers and limitations, and successes of integrating game-based learning in real classrooms. Prototypes and exemplars are offered as a means of focusing the field of DMAL on meaningful conversation towards establishing a “common set of standards and values”, which may become the foundation of DMAL (Barab, Dodge & Gee, p.18). This session and the research of the panelists, is a work-in-progress reflexively seeking audience critique and dialogue.

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## Working Examples in K-12 Classrooms: Creating a Culture of Participation with Social Media and Games

The objectives of this presentation include (1) detailing working examples of gaming and digital media offered as curricula in a K-12 school district, (2) outlining supporting structures to build a culture of participation around digital media and learning (DMAL), (3) acknowledging challenges, limitations, and barriers to implementation, and (4) engaging in discourse with symposia participants overtly sharing assumptions, influences, and approaches (Gee, 2009) as a means of garnering expertise and furthering research and practice with DMAL.

Creating a culture of participation (Jenkins et. al, 2006) supporting teacher and student practices with new media literacies is a complicated task. Sustaining transformations in knowledge-building, design, implementation, and experiences for students utilizing technology requires a research basis (Mouza, 2009) and “a socially-interactive reflective community of practice” (Angers & Machmes, p. 4). Furthermore, meaningful leadership with technology includes being mindful of the changing definition of literacy and schooling while “considering how the contexts for learning need to change” (Collins and Halverson, 2009, p. 140). Working examples provide researchers and practitioners the needed dialogue to understand and discuss digital media and learning (DMAL) research and its relationship to learning theory, select appropriate content and methods offering opportunities for social practices and collaborative work, and learn with tools and in online spaces (Barab, Dodge & Gee, n.d.).

Chronicling a K-12 districts' pursuit to establish a culture of participation around social media games, and emerging technologies, I offer authentic working examples aligning policies, professional development, resource allocation, curricular initiatives, and technical support necessary to support staff and student engagement with games and other forms of media. Through digital media demonstrations of innovative, in-progress implementations and invited critique, this discussion offers a tangible approach towards connecting research and practice with DMAL. Threading social media, mobile devices, and games or environments such as *Quest Atlantis*, *Gamestar Mechanic*, *Conspiracy Code*, and a newly created high school game design course into daily curricular offerings allows students daily opportunities to discuss, play, and design games; sharing the process, curricula, and student-produced work offers researchers and practitioners a concrete method of considering the potential of their work.

Curriculum, student work, teacher and student perspectives, and policies are presented as in-progress working examples, evidencing both the success and failures of social media, games, and emerging technologies in practice. Data sources in this context are exemplars and models of practice needing revision; both instances benefit from interdisciplinary discussion.

Participant dialogue around the examples presented may result in curriculum design iteration, novel approaches to addressing digital media and learning in-and-out of school contexts, and contribute veracity within the emerging field of DMAL. Rich digital media learning environments, games in particular, rarely exists within K-12 classrooms or curricula. Bridging DMAL research with the realities

of teaching practice in the context of discussion surrounding in-progress initiatives and examples holds promise for researchers directing future DMAL study, and teachers wishing to consider effectively incorporating gaming and emerging technologies into schooling.

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## Bringing in the Games: An Example to Work From Perspectives and Objectives

While research suggests the potential of games to promote academic oriented learning, many of these studies have been based on after school (i.e., Squire & Durga, 2008; Steinkuehler & King, 2009) and informal play spaces (Gee, 2003). In contrast, the culture of formal education embodies unique expectations and challenges for integrating games not experienced in the informal learning space (Gee, 2007), not only for the teacher but potentially for the leaner as well. This study was designed in two phases; at the onset inquiry was intended to provide a cross-case comparison between a game-based course and non-game-based course centering on course preparation, implementation, and the nature of the student experience, surpassing specific academic outcomes. During the second phase, findings and Implications were compiled into a working example format (Gee, 2009) has allowed this study to serve as a tool for sparking dialog and critical discussion among teacher education students and practitioners interested in games based learning.

Case study methodology (Stake, 1995), was used to compare two high school entrepreneurship courses, one (n=21) integrated with a commercially available video game, The Sims2 Open for Business, the other (n=25) was non-game-based and had been previously taught for three years using project-based-learning methods.

Data were collected through instructor and staff field notes, students' daily reflective journals, collection of student work, pre- and post-test results and formative and summative student feedback. The capstone project for both courses was a business plan evaluated by a panel of outside experts, which also served as an evaluative data point.

The working example features three prominent thematic findings: 1) Outcomes: Pre and post tests revealed only subtle difference in student outcomes. 2) Student Experience: Student feedback provided the most distinct differences between the courses. Negative feedback from a grouping of students in the game-based course indicated varying degrees of tension with students' epistemological framework of what constitutes learning, particularly school-based learning, versus playing a video game as a route toward learning. This was particularly strong among students identified as "good students" in other courses. 3) Course Design and Management: In the game-based course, each student played the same game, but individual engagement and in-game progress was quite individual. This required a stronger reliance on formative assessment techniques to gauge learner progress, as well as just in time learning strategies, including peer-to-peer teaching, to capitalize on teachable moments.

Transitioning from considering course preparation as *planning lessons to deliver content* toward *staging learning experiences* is a notable shift in the role of the teacher. This involves considering the course as a designed experience for learners rather than a collection of successively complex lesson plans concluded with an assessment, which is a departure from the traditional practices where daily lesson planning is preeminent. Learner feedback should remind us that the current grammar of schooling has worked for many students. Where learners' epistemological frames associated with school-based learning cause tension with innovative teaching strategies or interventions, care must be taken to orient the student to new methodologies and scaffold them toward developing new learner dispositions.

Compiling findings in to a working example format provided a case-based approach for pre-service teachers to consider the implications of integrating games into the classroom and particularly the cultural challenges students may encounter when asked to port outside of school practices into the formal setting of school.

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## Spaceship Artemis: Learning to Play and Playing to Learn

The purpose of this working example is to use a particular instance of game-based learning to illustrate the relationships and tensions between "learning to play" and "playing to learn." The example is based on analysis of student reactions to the computer game Spaceship Artemis in an undergraduate course on games and learning. The example demonstrates how design elements of the game and the structure of the overall learning experience supported both anticipated and unanticipated learning outcomes, particularly related to the students' ability to engage in meta-level reflection about the game and their learning. While games themselves are have become widely accepted as learning tools, much focus has been on the game itself rather than the conditions in which the game is used. This worked example illustrates the importance of both choosing an appropriate game and designing an appropriate context for game-based learning (Squire, 2011).

The focus for the example is a week-long sequence of activities organized around the game Spaceship Artemis. Artemis is a multiplayer, networked computer game that simulates a spaceship bridge, with players taking on positions such as Helm, Communication, Engineering, and Weapon Control. Over the course of a week, students were asked to (a) research the game prior to gameplay and write about their expectations for the gaming sessions (e.g., what did they think would be challenging), (b) play in small teams during two class sessions, and (c) reflect individually and collectively on the experience in an online class forum and blog. They were also asked to read several articles that addressed the social dimension of gameplay. Concurrently, the students also were playing World of Warcraft as an out-of-class assignment. Evidence used as the basis for this example included field notes from game play and class discussions as well as students' written reflections, compiled throughout the week.

Artemis was in many ways a success as a collaborative learning experience. Students quickly became engaged in gameplay, were intent on improving their teamwork, and became immersed in their roles. There was evidence of the development and use of distributed knowledge, a shared vocabulary, and enhanced ability to coordinate their efforts (Gee, 2003). The game also proved to be effective in supporting students' learning about teamwork, demonstrated in student reflections on

topics such as the importance of communication and the role of an effective leader. Their understanding of how the game's design features supported or inhibited knowledge-building and successful game play was also evident in suggestions for "modding" the layout of the game space, for example, moving the computers so that they could see each other's screens, or positioning the captain at the back rather than the front of the group. Notably, however, the students did not relate the game to other experiences they had in collaborative gaming, even though prompted to do so, and despite the fact that they were also playing WoW as an out-of-class assignment. Indeed, students only mentioned WoW when referring to one of the course readings focused on WoW.

In general, this example suggests the need for balance between "learning to play" and "playing to learn." While learning to play was crucial in providing students with a shared gaming experience that could serve as a basis for reflection, moving past the specifics of the game to broader insights requires perhaps more extended engagement than we provided in this instance. In fact, while we initially dismissed the students' requests for more Artemis game sessions as simply a desire for more play time, we realize now that further gaming, scaffolded appropriately, would likely be crucial to support their ability to think more deeply and critically about the game, its affordances, and more general models of learning in multiplayer games.

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## Improving Game-Inspired Structures In University Instruction

Recently, games and learning scholars (e.g., Squire, 2011; Gee, 2003) have advocated the use of games and game mechanics not as "teaching machines" (Skinner, 1958) to deliver academic content, but as tools to transform curricula. Motivational structures and decisions within games may help to move from an inordinate "content fetish" toward situating learners in forms of practice (Gee, 2004). This presentation presents a worked example (Gee, 2009) in this vein—an application of game-based learning to an undergraduate classroom, with the intent of determining how the application of gaming structures may affect the motivation of students, furthering discussion on appropriate uses of gaming as instruction.

Some have altered classroom structure itself to be more game-like (see Sheldon's, 2010, substitution of "experience points" for grades). Often, "games" are instantiated as reward structures or conflated with forms of credentialing ("badges" and "achievements," but not as valuable player practices). How can we best foster complex mechanics, multifaceted decision-making, and rewards tied to real consequences? In this worked example, the author builds on theoretical perspectives from game design (e.g., Salen and Zimmerman, 2003; Schell, 2008), which strongly direct that games are not considered only as motivators, but also as structures for decision-making. The perspective explored through this case is one in which valuable game-based learning is hypothesized to help build motivation by providing students with increased agency and consequence.

As a worked example (Gee, 2009), this presentation illustrates a curricular redesign of a collegiate undergraduate course where elements of games were incorporated into course participation. Specifically, a "participation tree" system (analogous to the "talent tree" customization systems that are part of many contemporary digital games) was added (building on Author, 2011). Student participation translated to a course grade but also to an "in-course currency" used for customizing course requirements (e.g., excused absences and changing the weight of assignments). Ultimately, the system was a failure (Author, 2011)—structures implemented in order to foster student participation had the opposite effect. Rather than participation, the system engendered a sort of "min-maxing" behavior, in which participation decreased when goals in the "participation tree" system were met.

And yet, this failure was a productive one, which will be further developed in this session. I present an assessment of the intervention's design, and "work" this example by exploring alternate configurations of fostering participation and assessment through the employment of game-like structures. That is, if we care about adapting game elements to non-game contexts such as instruction, care must be taken to determine which elements of instruction should be "gamified." Practitioners must understand the

dynamics of the system they are implementing (in this case, course participation), and through the exploration of potential modifications to these participation and assessment structures, it is the hope that a more nuanced understanding of game-based instruction (beyond simplistic "gamification") can be learned. A worked example provides the opportunity to take this initial attempt and iterate it, in public, with the intent of revealing productive new avenues for future research.

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# Serious Games in Embodied Mixed Reality Learning Environments

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**Abstract:** Four projects are presented that focus on the intersection of mixed reality learning and embodiment. Here we discuss four games designed to promote health and science education. All the games represent the vanguard of motion capture and skeletal tracking technologies for facilitating learning in a collaborative and exploratory environment. “Feed yer Alien” is a multi-user game created to educate younger students about nutrition. HALY is a yoga-based stress reduction scenario using a touch sensor glove. “MEteor” uses a laser-based motion tracking system and body-metaphor-based interactions to instruct in planetary astronomy. Finally, “Outbreak” is a group collaborative, systems-thinking game in the domain of disease transmission.

## Presentation 1: Two Games for Health: Alien Health (nutrition with motion capture) and Yoga/Color Stress Reduction (mixed reality)

Mina C. Johnson-Glenberg and Julie Cruse

### What is a technology-supported, embodied learning environment with motion-capture (TELEM)?

The Situated Multimedia Arts Learning Lab (*SMALLab*) is an example of a technology-supported embodied learning environment with motion-capture, a TELEM. *SMALLab* is an educational platform that engages the major modalities (i.e., the sense systems including visual, auditory, and kinesthetic) that humans use to learn. *SMALLab* uses 12 infrared motion tracking cameras to send information to a computer about where a student is in a floor-projected environment. The floor space is 15 X 15 feet and the tracked space extends approximately nine feet high. Students step into the active space and grab a “wand” (a rigid-body trackable object) that allows the physical body to now function like a 3D cursor in the interactive space.

The environment allows for co-located collaboration among the active students because four can be tracked at one time, but, more importantly, the other students sitting around the perimeter can also be engaged in the situated learning as they discuss with each other or call out testable hypotheses. For over eight years our lab has been exploring the boundaries of motion capture as it relates to K-12 and informal learning. We have recently been porting over the floor projected *SMALLab* scenarios into vertical wall projected interfaces so that Microsoft’s *Kinect* sensor can be used.

**The Promise of Embodied Learning.** Human cognition is embodied cognition. This means that cognitive processes are deeply rooted and come from the body’s interactions with its physical environment (Wilson, 2002). The role of embodiment in learning has been demonstrated in many domains including neuroscience (Rizzolatti & Craighero, 2004), cognitive psychology (Barsalou, 2008; Glenberg & Kaschak, 2002; Glenberg, 2010), math (Lakoff & Nunez, 2000), gesture (Hostetter & Alibali, 2008), expert acting (Noice & Noice, 2006), and dance (Winters, 2008). Pulvermüller and Fadiga’s (2010) review of fMRI experiments demonstrate that when reading words related to action, areas in the brain are activated in a *somatotopic* manner. For example, reading “lick” activates motor areas that control the mouth, whereas reading “pick” activates areas that control the hand. This activation is part of a parallel network representing ‘meaning’ and shows that the mappings do not fade once stable comprehension is attained. That is, these motoric codes are still activated during

linguistic comprehension in adulthood. In addition, increasing evidence in the study of gesture suggests that gestures facilitate speech about mental images (Hostetter & Alibali, 2008). Gesture may serve as a *cross-modal prime* to facilitate retrieval of mental or lexical items. If the physical movement primes (readies) other constructs (like language), then learning via movement may add an additional modality and prime for later recall of knowledge.

**Our embodied learning hypothesis.** Much content in western education is taught using abstract symbols, namely the symbols of language (words and syntax) and the symbols of mathematics. If the understanding of these symbols is not grounded on something outside of the system of symbols themselves, then it is difficult for many students to truly comprehend the meaning of the content. Bodily perception and action, and the experiences based on perception and action (Barsalou's perceptual symbols (2008) provide a mechanism for grounding). The scenarios designed by our lab are created to enlist as many relevant modalities as possible during the encoding stage, and to integrate as much peer-to-peer collaboration as possible. Our position is that the more modalities and **well-mapped, congruent afferent** sensori-motor activations that are recruited during the encoding of the information, then the crisper and more stable the knowledge representations should be in schematic storage. Watching others master the correct gesture and content will be a learning experience as well, however, the knowledge gained by observation will not be as durable as knowledge gained by action. Recent research supports that content learned in a high embodied condition (versus a low embodied, observational condition) was remembered better on a one-week followup test (Johnson-Glenberg, Megowan, Glenberg, Birchfield & Savio-Ramos, in preparation).

From the designer's perspective, creating a learning module with the highest degree of embodiment means that the module should encourage the student to physically activate a large quantity of sensori-motor neurons in a manner that is congruent to the content being learned. For example, if a student is learning about gears an rotation then a "push" gesture would not be congruent to the task, we suggest designing in a circular motion with the hand to simulate the direction of turn. When the velocity of the rotation, maps to the velocity of the visual graphic, we would consider this to be a highly embodied learning experience. The peer-to-peer collaboration that emerges from immersive, open platform learning is very different from what is seen in desktop learning situations, where students are often focused on their own screens. In addition, these platforms are ripe with observational learning opportunities and these should be thoughtfully and explicitly designed into the lessons.

After years of study, our lab has seen consistent, significant gains in learning when students are randomly assigned to the embodied mixed reality condition (see [www.SMALLablearning.com/research](http://www.SMALLablearning.com/research)). There are two hypothesized reasons for these learning gains: embodiment and collaboration. Due to space constraints, we only describe two of our newer scenarios without final results and recommend the reader visit either one of our two websites: [www.smallablearning.com](http://www.smallablearning.com) or the EGL group at [www.lsi.asu.edu](http://www.lsi.asu.edu)

### **Game 1: Feed Yer Alien**

*Feed yer Alien* is a nutrition and exergame that has been designed around three primary goals: 1) instruction on optimal food choices, 2) exposure to the new "My Plate" food icon, and 3) sustained moderate physical activity. *Feed yer Alien* is most appropriate for students in 3<sup>rd</sup> through 8<sup>th</sup> grade, but it is also relevant for adults. The game begins with the narrative of the player (you) finding a lost and hungry alien under your bed. You both can't communicate, but via trial and error you figure out what makes the alien feel healthier. Immediate sonic and visual feedback help you deduce healthy from unhealthy food choices. Coincidentally, the alien's body functions similarly to a human's. Below is a screen capture of what is projected onto the 15 X 15 floor space. At the center is the dynamic "my plate" icon which has recently replaced the food pyramid ([www.myplate.gov](http://www.myplate.gov)).

Two players are active in the game space at one time. One is the selector and the other is the transporter. A forced choice task is shown in the top right corner. Pairs of food items appear on the top of the play space, the selector hovers the motion tracking wand over an item and on the left of the space the nutrients in that item begin to glow. We highlight three nutrients (protein, carbohydrates and fatty acids) and two 'optimizers' (fiber and vitamins/minerals). Via collaborative discussion with the "transporter", who is standing near the nutrients, the team decides which of the two items is more nutritious. The selector picks the virtual item up, in this case the fresh blueberries, and with the wand brings it to the Alien's mouth. Now, it is the job of the transporter to select the glowing nutrients at the

top of the play space and actually “run” them down to the tissue at the bottom of the space in a timely fashion – if this nutrient transport happens too slowly the entire game will begin to dim. If the improper food choice is made (e.g., selecting ice cream with whip cream vs. frozen yogurt with strawberries) then the Alien begins to change color; his antennae and ears begin to droop. In this way, students get immediate feedback on which choices are better. After mastering several cycles at the food choice level, students move on to the portioning level. At the end of what is a five level sequence, the Alien reveals the “secrets of the universe” to the two active students in a manner that only they can see. We are analyzing results now on a study completed in May, 2012.

**Method.** Over a two hour time period, 24 4<sup>th</sup> graders played the Alien Heath Game. Pretest and posttests were administered.

**Measures.** Two separate instruments were administered. 1) *Food Choice Test* - A 13 pair forced-choice food item paper and pencil test has been created and piloted. 2) *Build a Lunch Task* – This experimenter-designed task assesses students' food choices as they build a lunch from 21 realistic plastic food replicas. The items ranged from very healthy (grilled skinless chicken breast) to very unhealthy (chocolate donut).

### **Game 2: HALY - Multi-modal Sensing System for Stress Reduction in Yoga**

**Healing Arts Lab for Yoga (HALY).** The first module created by HALY is an immersive visual and sonic landscape designed for community yoga classes aimed at reducing stress. The current implementation, which focuses on color only, is designed to allow the instructor to control the mood of and the color that is saturating a classroom while being thoroughly active and engaged in the teaching. The instructor is able to wear a comfortable glove with a Bluetooth *mudra sensor* in the fingertip that senses pressure and changes projected colors accordingly. The fingertip pressure is mapped to colors based on intensity. Thus, low pressure correlates with “cool” colors (blue, indigo, violet), and high pressure correlates with “warmer” colors (red, orange, yellow). Colors are projected into the environment by a downward facing projector. Color can have a calming effect on people (Madden, Hewett, & Roth, 2000).

**The System and Color Therapy Background.** HALY consists of a custom-designed glove that utilizes Bluetooth, a force sensitive resistor, a Lilypad arduino, and is powered by 3.3 Volts through a AAA battery in a Lilypad battery circuit. The Bluetooth sensor transmits the data to a Max / MSP patch which maps the sensor data to color visuals. The colors visuals are projected through a downward facing projector and feel immersive. The working hypothesis is that by combining immersive color therapy with a yoga environment, participants will report feeling calmer than when they are in a simple yoga-only environment.

### **An Embodied Taxonomy for Serious Games**

Our lab is creating a taxonomy to partition embodied, “kinesthetic” learning environments into meaningful categories so that falsifiable hypotheses can be framed. The education sector is now receiving the opening salvos from marketing materials claiming that virtually every tap on a Tablet screen is “highly embodied”. We would do well to pause and reflect on what it means for gestures to be embodied in a meaningful way that maps to the congruency of the content being learned. What affordances are necessary components in the embodied learning equation? How should the varying constellations (and magnitudes) of these learning affordances be ranked? To this end, Johnson-Glenberg (et al., submitted) posit three necessary components: 1) amount of motoric engagement, 2) gestural relevancy or congruency—how well-mapped the evoked gesture is to the content being learned, and 3) perception of immersion. These components can range from low to high; however, a useful matrix might be one that contained four degrees of embodiment. The 4<sup>th</sup> degree would be considered the highest.

4<sup>th</sup> degree= Includes locomotion which results in a high degree of motoric engagement; gestures designed to map to content learned; learner perceives environment as very immersive (Example – systems described in this symposium that include locomotion.).

3<sup>rd</sup> degree = No sustained locomotion, but large amounts of sensori-motor activation are present while stationary; some amount of gestural relevancy; learner perceives environment as immersive (Example - VR goggles, generative content on Interactive Whiteboards).

2<sup>nd</sup> degree = Learner is generally seated, upper body movement; interfaces should be highly interactive; with smaller display size of a computer monitor learner does not perceive as highly immersive (Example- constructive desktop simulations).

1<sup>st</sup> degree = Learner is generally seated, some upper body movement; primarily observes video/simulations on monitor (Example – view video on screen).

Our claim is that for a learning module to be considered *embodied to the highest degree* it should activate a large number afferent neurons in the learner's motor system – akin to what happens during Self Performing Tasks (Engelkamp, 2001) in the psychology literature. This combination of body-based muscle engagement and brain-based mirror neuron activation results in 4<sup>th</sup> degree learning. Removing the body-based (kinesthetic) component, will still result in learning; however, it may not be as durable as the learning supported by both forms of encoding.

## Presentation 2: Outbreak! An Embodied, Immersive and Collaborative STEM Learning Environment

Tatyana Koziupa, Mina C. Johnson-Glenberg, and David Birchfield

Outbreak! is a STEM (Science, Technology, Engineering and Math) game designed for the Situated Multimedia Arts Learning Lab (*SMALLab*) multi-modal environment. Multi-modal means that the learners use multiple senses (seeing, hearing, kinesthetic) to encode the information and integrate immediate feedback. Our lab co-designs all content with K-12 teachers and aims to systematically include opportunities for peer-to-peer or whole class collaboration in the scenarios because research supports the many positive effects of collaboration and cooperative learning in the classroom. (*SMALLab* is well situated for teaching about the complexity of human diseases because it is learner-centered, inquiry-based, and contains embodied learning experiences designed to better align real world experiences with abstract representations and conceptual models.

### Design and Development of the Disease Transmission Game

Outbreak! was designed with a high-school science teacher to address common misconceptions of disease transmission, including the difference between bacterial infections and viruses, the difference between antibiotics and vaccines, the meaning of antibiotic resistance, the difference between symptomatic and asymptomatic carriers, and the concept of limited resources. The scenario was implemented using design principles outlined in Birchfield et al. (2010b). We insured that it was collaborative, embodied and wrapped in an inquiry-based social game. Avatars were created by the students at a free website before the study began and then were imported into the game template. During each run, infection levels were randomly assigned to each avatar. Once the students successfully identified how the disease was transmitted – for example, via bacteria or virus - a new complexity was added to the system, e.g., asymptomatic carriers. In this way it leveled in complexity over a three day time period.

**Mechanics.** The health disc surrounding each avatar decremented with time and this motivated the students to retrieve more water or medicine in the central playing area. Unfortunately, the central area was also where they could get sick. Students needed to first deduce the method of transmission and then work through whether the disease was due to a bacterial or viral infection. The timing and efficacy of the medicine was crucial for figuring out this distinction. The lesson lasted for three days with increasing levels of complexity culminating in the asymptomatic carrier level where students needed to figure out who was the carrier without any visual cues attached to the avatar (i.e., which avatar was in the space at t-1 now that avatar X is sick?)

**Methods.** The Outbreak! study was run on a large urban high school with 56 students. The study was based on a six-day waitlist design. Three invariant (pre-, mid-, and post-) tests were administered to three classes, which were randomly assigned to group. Group 1 received *SMALLab* instruction then regular instruction (same teacher and same content); Group 2 received regular instruction then *SMALLab* instruction. A mid-test was given halfway through and then intervention switched. When students were in the *SMALLab* condition the Effect Size (ES) was always over .50 – when they were in the regular instruction condition the ES was below that – either .32 or .09 respectively.

### Results & Discussion

By Midtest the groups differed significantly, with greater gains favoring the *SMALLab* learning experience as compared to regular classroom instruction. A *t* test significantly favored the group that

received *SMALLab first*. We believe that the collaborative embodied experience accounted for this gain.

### **Conclusions & Future Directions**

This scenario was designed to foster systems thinking skills. The *SMALLab* mixed reality environment is an example of a highly innovative learning space for developing creative, non-linear, and operational thinking skills that are necessary for developing a systems thinking approach to problem-solving. OUTBREAK! allows the students to follow the inquiry-based learning model, and proceed through the scientific method to test their hypotheses in a supportive, yet rapidly evolving time frame that encourages multiple hypotheses to be posited, refuted or supported. It is highly collaborative. There were times when half the class was shouting out recommendations about whom to save and whom to “quarantine”. (To see video go to: [www.smallablearning.com](http://www.smallablearning.com) scenario: disease transmission).

### **Presentation 3: Embodied Learning in a Mixed Reality Game through Metaphor-Based Interactions- Meteor**

Amy Bolling<sup>1</sup>, Arjun Nagendran<sup>2</sup>, and Robb Lindgren<sup>1</sup>

Mixed reality environments are those that merge the real and the virtual, integrating real world environments with virtual elements and vice versa (Milgram & Colquhoun, 1999). The potential of using mixed reality to create new learning experiences and educational opportunities has been frequently cited (Chang, Lee, Wang, & Chen, 2010; Hughes, Stapleton, Hughes, & Smith, 2005; Kirkley & Kirkley, 2005; Pan, Cheok, Yang, Zhu, & Shi, 2006). Learning through physical interactions with MR has been referred to as type of *embodied learning* (Birchfield & Johnson-Glenberg, 2010). Recent advances in mixed reality technology permit the creation of immersive environments capable of seamlessly integrating a learner's real world movement and activity with digital representations. Relatively inexpensive infrared and laser-based motion tracking systems make it possible for these environments to be highly responsive and interactive without the need for users to wear heavy and intrusive technologies (e.g., Snibbe & Raffle, 2009); this means that learners can freely explore digital spaces with natural physicality. Given these affordances, we have created a mixed reality environment that aims explicitly to support *body-based metaphors* in which participant learners interact with the environment as though their body was a part of the representational system.

### **Mixed Reality in Informal Science Education**

The mixed reality game, “MEteor,” is designed as an interactive physics exhibit that can be installed in a science center. According to the recent report simulations and games may be particularly effective at increasing excitement in the subject matter and motivation for continued learning (Honey & Hilton, 2011). This makes the use of simulations and games using mixed reality technologies in large exploratory spaces especially applicable to informal environments such as science centers. Indeed, many science centers have begun to embrace these technologies in recent years, although rigorous research on the specific effects of these experiences on visitor learning and engagement has been sparse. We seek to build upon this work to show specific affordances of mixed reality environments for supporting cognitive processes.

In the MEteor game we are employing *functional metaphors* to help learners construct an understanding of planetary physics. The metaphor “learner as asteroid” is embodied in the sense that we are asking participants to enact the metaphor using their own bodies and “functional” in the sense that through this behavior they draw similarities between the way physics functions and the functions they are performing. Through this functional-embodied metaphor, the subject's body becomes a component (an asteroid) in a complex system (planetary astronomy). Through their own physical actions the subject learns about the behavior and important relationships that govern the system.

### **Project Design**

The goal of this educational game is to facilitate science learning through whole-body interactions. The game was designed for middle school-aged children to explore the world of planetary physics through their interactions with functional metaphors. We are currently conducting studies on the game at our lab and the game will shortly be installed at the Museum of Science and Industry (MOSI) in Tampa, FL. The science concepts explored through this serious game are Newton's laws of motion and Kepler's laws of planetary motion.

Five levels of the game were designed to lead the student through the increasingly complex laws of motion. In this immersive mixed reality environment, there is a zone on the floor in which the student maintains control over the motion of the asteroid (a “launch” zone, followed by a zone in which the asteroid is controlled entirely by the laws of physics. In this second zone, the student must do his/her best to keep up with the motion of the asteroid and is scored according to how well s/he predicts and follows the path of the asteroid. Whether or not the students actually hit the target is secondary to their ability to predict its motion and move accordingly. Thus, the feedback that the participant receives through graphs and imagery on a large wall or floor projection is focused on the distance between the student and the asteroid over time. The student is scored on each trial. In the second and third level of the game the student must hit the same target which now lies on the opposite side of a large planet and a smaller planet respectively. In order to hit the target the student must get a sense for how the presence of this planet affects the trajectory of the asteroid.

### **Learning Research**

This paradigm for enacting functional metaphors in a mixed reality environment is already showing benefits for learning. In preliminary studies described in Lindgren and Moshell (2011), we found that participants who used MEteor were more likely to include dynamic elements (arrows, etc.) in their astronomy drawings compared to participants who used a desktop computer version, indeed 52% of participants in the whole-body condition created sketches that represented movement compared to 41% of participants in the desktop condition. MEteor participants were additionally less likely to include “surface features” (graphical elements that were in the simulation but not really important to the physics being learned) in their drawings. Having participants make drawings of the simulations proved to be a highly informative measure of a participant’s remembered experience. Other measures include picture-based surveys of science self-efficacy and an analysis of a learner’s gestures while playing the game. We believe this new approach to informal science education is already showing great promise. We know that games that incorporate physicality into their scheme of interactions can be engaging. The current work indicates that these games can help develop important forms of conceptual understanding as well.

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# EDemocratized: A Democratization of Educational Assessment

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**Abstract:** How might educational assessment be democratized and made more meaningful and engaging for students? Too often, assessment is separated from the pleasures of learning, like a painful test after the game, or worse, a boring class. We propose a symposium to introduce a design experiment with iPad graphics and user narratives called ECDemocratized and initiate discussion around democratization of educational assessment. ECDemocratized is designed to blend the principled assessment design framework, Evidence-Centered Design, with a power shift to give students new agency over their assessment. While ECDemocratized is not a game, it will draw on lessons from games about mediating feedback and gathering data as part of player engagement. Can we democratize current educational assessment practices by introducing a digital media tool that incorporates new learning and assessment theories? Let's find out.

## Introduction

High stakes testing has led to the proliferation of pedagogical approaches that treat the student as a vessel to be filled with knowledge, evidenced by the increased pressure on schools to teach to tests. This has the effect of increasingly rendering knowledge inert (Whitehead, 1929), consisting of facts about a domain, with distant and diminishing utility for authentic use. In this assessment regime, tests are treated as the best—and potentially the only—option for collecting and evaluating evidence for monitoring the learning of children, and the performance of schools.

Simply put, the current practice of educational assessment is based on the outdated learning theories and a psychometric tradition that often emphasized students' content knowledge without context. In contrast, contemporary cognitive and learning science theories support sociocultural and situative perspectives of learning where students interact with their social and cultural environments (i.e., activities, resources, teachers, and peers) to develop knowledge and understanding of the world. Thus many strongly argue that we need to move beyond testing content to incorporate more complex aspects of learning (Moss, Pullin, Gee, Haertel, & Young, 2008; Pellegrino, Chudowsky, & Glaser, 2003).

Another problem of current assessments is that it alienates the most important stakeholder in learning: the student. Stiggins (2002) once noted that,

*We are a nation obsessed with the belief that the path to school improvement is paved with better, more frequent and more intense standardized testing. The problem is that such tests, ostensibly developed to "leave no student behind," are in fact causing major segments of our student population to be left behind because the tests cause many to give up in hopelessness -- just the opposite effect from that which politicians intended. (p. 2)*

It is very difficult for students to feel ownership in the learning process when they are assessed by others' standards and rubrics—especially when they are not given support to understand how the assessments are really being made. Yet blaming these standards is premature when the testing infrastructure and designs are focused so purely on serving administrators rather than students. To students, it is not the standards but the assessment experience that can be punitive and lacking in formative guidance.

Addressing these problems can help shape educational reform at large. As Gee and Shaffer (2010) strongly argue, changing assessment is essential to making any deeper changes in what and how students learn. Yet assessment theory alone can be incremental and reactive. We propose a design

research intervention to illustrate what assessment can look like as an important component of 21st century education.

The goal of this symposium is twofold. First, it is intended to open up discussion about what democratized assessment is and how we can accomplish it using digital media technology. Second, this symposium intends to ground often-abstract discussions of assessment in a specific context by introducing an iPad application called *ECDemocratized*. Particularly, we focus on the potential for overlap between student engagement and assessment rigor. That is, our design research is a way to investigate if digital media can provide a middle-ground with both psychometric rigor *and* the flexibility to engage and empower students. We will also highlight how such an application can be embedded within school curriculum, and discuss core design features of the application using an example of Rube Goldberg projects. The panelists of the symposium include Adam Ingram-Goble, Ben Shapiro, Benjamin Stokes, Yoon Jeon Kim, and Peter Wardrip who are currently developing ECDemocratized; and two assessment experts as respondents, James Paul Gee (Arizona State University) and Russell Almond (Florida State University). The resulting symposium will be provocatively concrete, include responses from former teachers, and aims to start a new conversation about the goals and democratic possibilities of assessment in schools.

## Theoretical Frameworks

### Situativity Theory

Drawing on situativity theory (Brown, Collins, & Duguid, 1989; Greeno, 2006), we believe that we can engage students and teachers in the collaborative development of assessments. In the process, we hope to increase the transparency of the act of assessment, to alter the relationship between work and the assessment, and to help teachers to make the assessment process more iterative and formative. Fredericksen and Collins (1989) utilized the word “transparency” to stress the importance of students understanding the criteria by which they will be assessed. As Lave and Wenger (1991) point out, participation in the activity cycle of work is as important to the learning process as any one task. Indeed, the activity, context, and purpose of work are inseparable in traditional non-school based sites of learning. Informal learning contexts are increasingly relevant models, especially as we seek to make learning more authentic to applied domains of expertise and relevant to student passions in order to maintain engagement.

There are three problems of educational assessment that are emphasized by our design research. Note that by “democratizing” we refer broadly to a state of affairs whereby those involved in the assessment process—from students to teachers and parents—have more power over the things that matter to them. First, assessment is too often executed as *separate from learning*, as illustrated by specialized and separated testing as well as the abstract language and processes that are opaque to students, and in some cases teachers. Such separate assessments distract from why learners are in school, which is quite simply to learn (not to be tested). Our design is based on the assumption that the contexts and activities in which people learn are fundamental to what they learn (Greeno, Collins & Resnick, 1996). Separate assessments are subsequently perceived as a burden on teachers and students without a return on the learning they care about.

Second, assessment is *rarely done with students*, even though the results have an impact on the student’s life—from college admissions to employment. When the stakes are high, students care about the outcomes, and yet they often have no power over how assessments are constructed or administered. ECDemocratized positions students as co-creators of the assessment with teachers, thereby changing the power dynamics of the classroom, and thus helping students gain ownership over the learning process (in the model of Shepard, 2000). By democratizing assessment, students will gain a greater sense of agency. The development of agency should be intrinsic to the learning environments we design (Greeno, 2006).

Third, current assessments *rarely empower students with assessment skills*. This leaves students at a disadvantage, unable to articulate the value of their own learning, and unable to meaningfully apply assessment for their own purposes. Especially in the modern information economy, our work only counts when we can articulate why it has value as a competency, and students need the skills to pick the value system within which they will be judged. ECDemocratized forces students to debate their assessment criteria with their peers, offering an opportunity for students to cultivate their identity in relation to the disciplinary vocabulary. Great teachers already spur such discussions, but not as part

of formal assessment. We propose that a digitally-mediated assessment process could also spur conversations for reflection and identity formation, as part of the student becoming a member of a disciplinary community (Greeno, 2003).

In sum, the ECDemocratized seeks to empower students to participate in the full ecological cycle of their own learning and assessment.

### **Evidence-Centered Design (ECD)**

ECDemocratized is based on ECD, and its approach to making “evidentiary argument.” ECD itself is an assessment design framework that supports collaborative design with rigor (Mislevy, Steinberg, & Almond, 2003). Specifically, ECD fosters rigor by emphasizing the coherence and fit between evidence collection and the interpretation of results for the learning goals. Coherence is fundamental in order to make broader claims about students. Importantly, achieving this coherence comes through social negotiation between stakeholders. This negotiation is an excellent content for democratizing power relations between actors, beginning with conversations about what counts as evidence and why they think that evidence is important.

Three conceptual models of ECD are echoed in the design of ECDemocratized:

- *Competency Model*: A competency model concerns what is the claim that we want to make about a student at the end of the assessment. A given assessment is meant to support making claims or inferences about students at different levels of competency, and variables in the competency model usually describe the set of knowledge, skills, ability, and other attributes of students on which inferences are to be based.
- *Evidence Model*: An evidence model expresses how the student's interactions with, and responses to a given problem constitute evidence about competency model variables. The evidence model (EM) attempts to answer two questions: (a) What specific behaviors reveal targeted competencies?, and (b) What is the functional or mathematical connection between those behaviors and the CM variable(s)? Simply put, an evidence model lays out the argument about why and how the observations in a given task or situation constitute evidence about CM variables.
- *Task Model*: A task model (TM) characterizes and constructs situations with which a student will interact to provide evidence about related competencies. That is, TM specifies what the student will be asked to do and what kinds of responses will be submitted. Tasks are the most obvious part of an assessment, and their main purpose is to elicit evidence (which is observable) about competencies (which are unobservable).

ECDemocratized will embody the very fundamental idea of the ECD approach by engaging students in collecting evidence, choosing between assessment criteria, arguing how the collected evidence does or does not satisfy the criteria, and structuring the collection of evidence as an argument for project completion.

### **Games + Learning for Assessment**

Finally, our approach to assessment design is also heavily influenced by the growing literature on digital games for learning (e.g., Gee & Shaffer, 2010). Well-designed games are inherently engaging, with embedded ongoing assessment mechanics that are tied to the game tasks. Also, games provide implicit and explicit feedback about players' performance, and players must use that information to be able to succeed in the game and enjoy it. Similarly, productively “failing” in games is a normalized experience for players, which promotes opportunities to learn by iterating through solutions and strategies. All these activities are not separated but instead are seamlessly merged together in games. Even though ECDemocratized is not a game, it transforms assessment as a *game-like* activity because (a) it leads students to actively and continuously interact with the assessment process as part of what makes it pleasurable, (b) it makes students' accomplishments and failures explicit and visible in ways that are useful for the learner to proceed, (c) it mediates the feedback in real-time, yet is based on countless hours of testing to ensure that the assessment is meaningful to the participants themselves.

## How ECDemocratized Works

ECDemocratized is both an iPad application and a curriculum, grounded in the psychometric rigor of ECD. ECDemocratized works by guiding students over several weeks to use their iPads to make evidentiary arguments in the form of pictures they take, audio they record, and text they write. Students progressively link together their multimedia to make evidentiary arguments for their competence in a domain of expertise.

At the same time, ECDemocratized will give students some power to choose the learning goals themselves. This process is semi-structured, both by the app and by how the teacher implements it. The underlying ECD theory is very compatible with this approach, since ECD is fundamentally about aligning assessment goals with the evidence available. This is unusual—normally assessment goals are not allowed to evolve, especially in response to student demands. ECDemocratized scaffolds this process by first providing the students with a complete assessment model (as set by their teacher), before allowing them to suggest modifications to the underlying rubric. Through this scaffolding, the app avoids overwhelming students with a blank-slate of unlimited assessment options (this is a problem with entirely “open” portfolio systems), and instead seeks to provide them with what game designers would call ‘*meaningful choices*’ between assessment possibilities.

ECDemocratized is designed as a supplement to existing classroom projects, especially those that take place over several weeks and lend themselves to photographic documentation. We find that engineering labs have particular promise as test contexts.

The simple act of taking pictures becomes a reflection activity, in part because the act of preservation implies a future use, and presumes a future audience. As a photographer, the student is forced to be proactive, choosing moments that matter and ignoring those that distract. This process of curation is a natural and ongoing reminder about the underlying goals for the activity, and the presence of rubrics that will be used to indicate success.

Concretely, consider an ECDemocratized physics lab where the students are asked to demonstrate systems thinking around simple machines in Rube Goldberg projects. Rube Goldbergs are a classic middle school physics lab wherein students must use engineering machines like ramps and levers to accomplish an amusingly simple task, like turning off a light bulb. As they build the physical Rube Goldberg device, the student group will also use their iPad to capture evidence, and structure evidence into arguments about their mastery of physics concepts (like the conservation across kinetic and potential energy), ultimately argue for their competence as systemic thinkers.

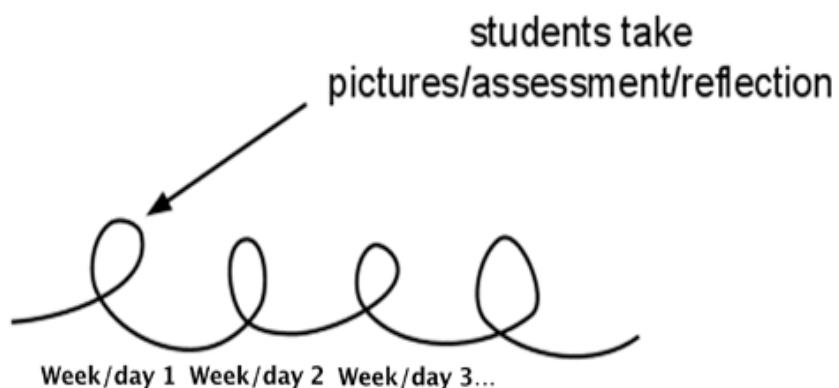
Of course, systems thinking has many possible indicators. Working from the notion that a system is a set of things interconnected in a way that produces their own pattern of behavior (Meadows, 2008), students would first be challenged to “define” the concepts of systems thinking salient to their work. By using drag-and-drop on their iPad, they would select three to five concepts to emphasize. For example, students may highlight the constitutive parts of their Rube Goldberg and highlight the multiple interconnections that impact the Rube Goldberg carrying out its task. The result is a personalized competency model for systems thinking. This competency model could also include the students’ design skills for building their Rube Goldberg. This might include planning by storyboarding or the generation and analysis of alternative methods of movement for their Rube Goldberg device.

Once their model is complete, they would similarly choose several possible indicators for each component in the competency model. The irony is that this general process is nothing new—many teachers must already tackle similar logic chains to align with national standards—but it is rare that students are given the power to not only gather their own evidence, but to refine the model, and see how particular models fit with the kind of evidence they iteratively collect. We hypothesize that this process will be empowering and will not only improve outcomes on traditional standardized tests, but it will also lead to new meta-cognition.

As students progress in the project, they may collect new and better evidence for the criteria. They also engage their small team in reviewing how they have been assessed. This could change the group configuration, where a team of 3 students may assign one person at a time to be in charge of “documentation” while the other two are building. Throughout, the teacher will have access to the evidence collected by each group, creating opportunities to engage students in their thinking about evidence and the criteria, both online and in direct discussion. This offers a level of transparency to

the assessment process, both for what the teacher is expecting of the students and the extent to which the process is facilitating the growth of the learner. At the end of the day or week, student groups will “swap” their portfolio with another team, asking for their input on whether specific pictures and videos are convincing for the argument they are trying to make. This social negotiation among peers serves at least two learning goals. First, it exposes the students to their peers’ use of evidence in their own learning process to critique and observe. Second, it enables the students to check how their own choice of evidence supports their argument with different audiences.

The process is iterative (see Figure 1) involving weekly (or at any interval that is appropriate for the given project) formal reflection on the evidence that has been amassed and the claims it supports. With each cycle, students’ abilities in collecting and arranging evidence will grow and become more sophisticated. Several weeks are likely to be necessary to see the growth in meta-cognition around assessment, and to justify the additional investment that the classroom teachers must make in establishing the system and dedicating scarce classroom time.



**Figure 1: Assessment cycles embedded in student work**

As they develop their thinking about how assessment works, students will develop the assessment skills and dispositions that are increasingly necessary for careers that require constant learning—where the criteria for success are complex and articulating that success is vital. Rather than primarily serving to help sort students as might be construed from the test-driven assessment paradigm, assessment with ECDemocratized aims to support students by fostering skills and motivation to leverage assessment for their own lifelong learning by treating assessment as a 21st century skill.

Key to treating assessment as a 21<sup>st</sup> century skill is our explicit view of epistemological pluralism, or “...accepting the validity of multiple ways of knowing and thinking” (Turkle & Papert, 1992, p. 3). This not only makes explicit the varied types of evidence from which the students may draw in order to richly defend their evidentiary arguments. In addition, this potentially engages them in epistemological conflicts with their peers around what constitutes sound evidence for a particular argument.

ECDemocratized ultimately seeks to develop a participatory assessment system. Here, students not only collect their own evidence, but also take turns evaluating each other. In this way, assessment becomes an iterative social conversation, always toward making improvements in the product of labor rather than passing judgment on the laborer. Moreover, the evidence of learning and competency is collected by students in order to form arguments. This is similar to the way that storyboards are used in legal courts, giving the evidence narrative coherence. Ultimately, the collection of evidence is made transparent to teachers, who see a “classroom view” as well as a “student view.” The teacher can zoom in to see the evidence and arguments that each student is making, and which learning standards this evidence is connecting to.

## **As a Provocation to the Field**

As a provocation, ECDemocratized aims to stir a conversation among education scholars, well before it launches as a product in 2013. Here are some contributions it aims to make:

- *Building theories*: ECDemocratized explores the intersection of assessment and design. The process of co-assessment serves as an additional learning opportunity with implications for the students' identity construction as well as their feeling of empowerment.
- *Assessment as 21st century skill*: ECDemocratized will offer a clear model for situated assessment that builds meta-reflection about the very nature of assessment itself. Identifying learning goals, making claims about learning with self-selected evidence, critiquing one's own as well one's peers' assessment choices and evidence serve as valuable components of building lifelong learning skills.
- *Open and extensible platform*: ECDemocratized can guide other projects to create their own iPad and mobile tools for learning by incorporating embedded assessment and documentation into the design.
- *Assessment policy connection*: Projects such as the Gordon Commission's report on the future of assessment, and the PARCC and Smarter Balanced consortia for the development of common core state standards assessment are currently investigating the role of assessment for 21st century schools. In addition, there are broader efforts of foundations like Gates and MacArthur that are investigating how to embed and situate assessment into digital media and learning. These policies will benefit from a rich example of assessment on mobile/iPad media embedded in science classrooms.

## **Discussion by James Gee: Implications for Education Reform**

In these remarks, I will react to the specific and unfolding design of ECDemocratized from the perspective of school reform. Where appropriate, my remarks will provide some historical context for reform efforts, but they will primarily focus on where we can go next, and how this application does (and does not) hold promise as an exemplar.

Over the last decade, the issue of testing has become central to school reform efforts in the United States (McNeil, 2000). Demands for the "accountability" of schools has led to an emphasis on basic skills (e.g., reading, math, and science), and teaching to the tests; this has sacrificed opportunities for active and critical learning. However, current work in sociolinguistics, cognitive science, and literacy studies suggests that a more complicated view of learning, assessment, and equity is required. Most importantly the primary stakeholders of these maligned assessments—the teachers and students—remain voiceless on what and how they are assessed, and how results of assessments are used. A tool like the ECDemocratized can provide a "sneak peek" to what accountability might look like under a more democratic paradigm for assessment.

I will especially analyze how ECDemocratized might provide an opportunity for students to learn reflexivity and to synthesize—especially how their knowledge and skills fit together, and how this knowledge is situated. Such synthesis is necessary for the knowledge to be authentic, and for its future application. We might call this systems thinking, which requires understanding of how the knowledge is situated in a community and semiotic domain. For equity in education, students must engage in critical learning, which means going beyond understanding of how to produce meanings in that domain, and, in addition, how to think about the domain at a "meta" level as a complex system of inter-related parts.

My provocation will address the kind of inter-related parts that are implied by ECDemocratized, and I will challenge the audience to reflect with us on what might be missing, and how it might be addressed.

## **Discussion by Russell G. Almond: Informal versus Formal Models of Assessment Design**

Evidence-centered assessment design owes much of its structure, including its name, to Schum's 1994 book, *The Evidential Foundations of Probabilistic Reasoning*. While ECD works at a qualitative

level, which is where this App aims, it does so in large part because the informal qualitative argument can be mapped onto the more formal probability model. In the first part of this discussion, I will explore to what extent the mapping between the qualitative arguments captured in the App can be mapped back onto the more formal mathematical models of ECD.

Zapata-Rivera and Greer (2004a,b) describe a similar system. Here students use a graphical representation of the proficiency model to start a dialog with their instructor about their levels of proficiency. The second part of my commentary will be to draw parallel and lessons from that work to the current proposal.

The third issue is that a large part of “democratizing” ECD involves sharing ECD models. There are several technical (e.g., common data formats), practical (e.g., common meta-data for classifying models), and legal (e.g., restrictions caused by copyright, patent and distribution rules in the Apple App store) which could prove challenging.

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# Translating “Games and Learning” For Non-Expert Audiences: Opportunities and Challenges

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**Abstract:** While there are several areas of shared understanding within the GLS community about the learning value of games and other digital technologies, less attention has been paid to translating these for “non-expert” consumer audiences, such as parents and teachers. We invite attendees to participate in our discussion of how to communicate information and provide guidance about the learning value of games to “non-expert” audiences. As organizations that are serving the public from different vantage points, we provide data and real examples about how consumers understand the links between digital media and learning, especially with respect to 21<sup>st</sup> century skills. We then share some dilemmas we have grappled with while forming evaluation criteria for the learning potential of digital media products. Finally, we consider best practices for presenting products to public audiences, emphasizing the importance of not overpromising learning potential and underscoring the important role that parents or teachers can play.

## Introduction

It is a testament to agreement among the academic community about the learning potential of games and other digital technology products (e.g., apps for mobile devices) that we now have both a *Digital Media and Learning* conference as well as a *Games+Learning+Society* conference, among several other forums where we gather to discuss these topics. There is a growing literature on how games can be used to positively promote learning. For example, Gee (2005, 2009) argues that many of the key principles in good games, such as promoting systems thinking and risk-taking, are also ones that are indicative of excellent learning experiences more generally. Squire (in press) discusses the potential for gaming to impact formal and informal learning spaces because games can help children develop knowledge, skills, and interests that are personally meaningful to them. Steinkuehler and Chmeil (2006) show how scientific habits of mind (e.g., informal reasoning and social knowledge construction) and not just rote memorization of scientific facts—can be fostered in popular games such as *World of Warcraft*. The National Research Council (2011) is beginning to consider how to scale up games and simulations for science learning.

Built on the premise that well-designed digital media products can engage kids and promote their learning of a variety of skills, this symposium asks how we can translate some of this research to a lay audience of consumers (parents, teachers, and potentially, kids/teens). Although this endeavor has not been at the forefront of the academic discourse, it is of prime importance (Kendall-Taylor, Lindland, & Mikaluk, 2010). Kids are engaged in a participatory culture (Jenkins, 2006) in which they consume and interact with digital media products both in and out of school. The role of adults in kids’ lives is key to whether and how they interact with these products. We hope that by providing relatively rich information to consumers about the quality of digital media, we can elevate the conversation about the design of digital learning opportunities and tools and ultimately spur smart demand for high quality products.

## The Need

Children/teens spend more time with digital media than they do with their parents, on average. Outside of school time, they (ages eight to 18) spend an average of seven hours and 38 minutes with entertainment media (Kaiser Family Foundation, 2010). At the same time, many adults are unsure about how to find quality content. Companies like Zoodles, Kindertown, and SmarTots aggregate digital media titles for parents. But these services usually provide little context about child development, learning, or co-play, and very little third-party evaluation of quality. When polled, parents actually express a strong interest in having their children develop 21st century skills (although they may not use the same terms)—through digital media and through more traditional routes as well (Common Sense Media, 2011). Twenty-first century skills are ones such as communication and collaboration that tend to cut across content areas and involve the synthesis of information nimbly and

creatively (The Partnership for 21st Century Skills, 2009; The New Media Consortium, 2005; Gardner, 2005). Twenty-first century skills are also often fostered in games (Thai et al., 2006). The same poll showed that parents are seeking engaging learning opportunities for their children, and are looking for information and guidance to help them make smart choices. Given this need for reliable information about digital media and learning, the symposium will center on opportunities and challenges involved in translating such information in public-friendly ways.

## **Key Questions**

In our various roles, we (the authors) bring information to public audiences about the learning value of games and other technologies, or design educational games and other tools for mass markets. Based on our work in these arenas, we have identified three questions to structure our discussion of the opportunities and obstacles that arise when researching and translating information about digital media and learning to parents, teachers, and other relatively “non-expert” audiences:

1. How do parents and teachers think about digital media, and what are their attitudes about 21st century skills?
2. How do we define the “learning potential” of digital media products and what criteria should we use to make an assessment?
3. How do we communicate information about learning potential to parents and teachers without overpromising outcomes?

We will investigate the above three questions in-depth and invite symposium audience perspectives as well. Some examples of the discussion that will be associated with each one follow.

## **Games, Learning, and 21st Century Skills**

Do parent consumers buy into the notion that games have potential to enrich their children’s lives? We first present research on parents’ and teachers’ attitudes towards digital media and learning, “21st century skills”, and family media management, based partly on results of a national online survey of 1,100 parents of children aged 2-17 and 300 teachers Pre-K to high school (Common Sense Media, 2011), such as:

- Parents and teachers are generally positive about the learning potential of digital media and seek a variety of learning benefits for their children from digital media. But, they aren’t sure whether current products actually deliver on this potential.
- Parents are interested in academic learning domains (subject area competencies like math and science), as well as future-leaning cognitive skills (critical thinking, creativity), learning dispositions, and socio-emotional skills.
- Parents currently turn to familiar resources like teachers and other parents or test out products themselves, but are looking for resources to help them evaluate the learning potential of digital media.
- Teachers and digital media savvy parents (frequent and sophisticated media users, who tend to be younger, more involved in kids’ media use, encourage kids’ involvement in both media and non-media-related activities) are the most optimistic about digital media and their potential for learning, and most interested in resources to evaluate media.
- Parents associated video games with reasoning (41%) and, to a lesser extent, creativity (30%), curiosity (26%), and collaboration (26%).

We also discuss research from think-tanks such as the Joan Ganz Cooney Center, and primary research on 21<sup>st</sup> century skills fostered through games (Dikkers, 2009).

## **Defining and Assessing Learning Value of Games and Digital Media**

One of the first major decisions that groups have to make when communicating about games and learning to non-experts is about terminology. We also need to determine what elements of learning hold value for parents. We discuss how formative research and market research can help shape choices in communicating about learning. We provide some examples of how we developed a vernacular to talk about learning, and how certain specialized terms (e.g., systems thinking) had to be translated into more user-friendly language.

While we discuss the importance of using a vocabulary that is familiar to non-experts, we also think it is important to educate parents or teachers about aspects of learning within media and technology that they might not yet know about. For instance, parents tend to know little about design principles in games and digital media more broadly. Likewise, they may be less familiar with 21<sup>st</sup> century skills and

more open to traditional academic subject domains. We will address questions about how to balance non-expert views of learning with more academic ones and how to assess learning value using a rubric that has to eventually be parent- and teacher-facing.

## Information, Without Hype

Finally, the symposium organizers will facilitate a discussion about how to present games and other digital media products to “non-expert” audiences. Despite providing information about the learning potential of products or designing products to *be* educational or supporting the R&D of such products, the authors will underscore the importance of not over-selling learning value. Given contextual nuances and the role of surrounding ecologies in the use, appeal, and effectiveness of any learning tool, we feel it is important to convey the conditional nature of learning to non-expert audiences. We will invite symposium attendees to participate in a discussion about how to communicate this effectively and in a way that inspires trust. We will showcase some samples to spark conversation. How do we respect the complexity of learning and learners and encourage digital literacy, while also keeping in mind the reality of many parents’ desires and decision-making and acknowledging their fears (e.g., displacement as a parent/teacher, fear of the technology, etc.)?

## Conclusion

A major goal of this symposium is to catalyze conversation about how to communicate with parents, teachers and other relative “non-experts” about the role of games for learning in children’s lives. We will present data on parents’ attitudes about digital media and learning and 21<sup>st</sup> century skills, discuss the vernacular of and criteria by which to evaluate games and other digital media for learning, and facilitate discussion among the GLS community regarding best practices for communicating with lay audiences about these topics.

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**Well Played**



## Super Meat Boy

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**Abstract:** *Super Meat Boy* (2010) playfully draws on the representational tropes and narrative conventions popularized by classic video game platformers, while simultaneously improving on the core design principles found in this popular genre. In particular, this game invites players of different skill levels to best its tiered challenges, which scale elegantly in difficulty from one level to the next. With its tight controls and its non-punitive punishment system, *Super Meat Boy* demonstrates that an ostensibly “hardcore” platformer can nevertheless appeal to broader gaming audiences.

### Super Meat Boy

Meat Boy is a sprinting, leaping, sliding cube of bloody red meat. Meat Boy is also a love letter, albeit an unconventional one. The independently produced multiplatform game that bears his name, *Super Meat Boy* (2010)—sequel to the 2008 online and free-to-play *Meat Boy*—is a love letter to the 8-bit platformers of the 1980s and 1990s. *Super Meat Boy* is also a love letter to players who poured countless hours into those often grueling and unforgiving side-scrolling adventures. The game was a breakout hit for its creators Edmund McMillen and Tommy Refenes (Team Meat), with *Super Meat Boy* (*SMB*) earning a number of “Game of the Year” awards and going “platinum” (selling over a million copies) in only a few short months (Yin-Poole, 2012, n.p.).

*SMB*’s success is no accident; indeed, the reason for the game’s critical and popular reception is (at least) two-fold. First, it lures gamers to it with its incisive, self-conscious aesthetic and intertextual references. *SMB*’s tongue-in-cheek characters and its thoroughgoing black humor satirize the common platforming mechanics and narrative conventions from yesteryear. The game clearly knows and appreciates where it came from. But this by itself would amount to little more than window-dressing were there nothing more to hang these cosmetic design choices on. After all, video gamers are not for want of retro-chic titles that openly trade in gaming nostalgia.

The second, and far more significant reason for *SMB*’s success, is that it improves markedly on the core gameplay design that characterized its forbearers. 8-bit platformers are notoriously arduous, onerous, and capricious puzzles. Moreover, they are often unfair. They are labeled as such because they punitively punish players for the games’ own design failures, including (among other problems) wildly uneven levels of difficulty and broken programming (i.e., the game is “buggy” or “glitchy”). *SMB* is not a simple re-imagining of previous titles. Rather, it is in effect what a great many of those previous platformers *should* have been. These interrelated points—the retro art style and its tight, gameplay design—will be assessed in turn to demonstrate why *SMB* has been lauded by gamers and critics despite its considerable difficulty.

### Super Treat Boy

*Super Meat Boy*’s inspiration begins with the title itself, or rather, with its abbreviation. It is not surprising that McMillen and Refenes would choose to model their game after what is arguably the best-known platformer of all time: *Super Mario Bros.* (1985). Shigeru Miyamoto’s Nintendo classic is more than abstract inspiration for Team Meat. Indeed, they considered *Super Mario Bros.* to be an unofficial design template. According to Edmund McMillen: “When Tommy and I talked about attempting to remake the Mario formula, we didn’t really discuss it publicly. Nothing could ever touch Mario, and nothing has ever come close, but as a designer I desperately wanted to at least try. *Super Meat Boy* is *Super Mario Bros.* if Tommy and I made it. If we had made a design doc, it would have been as simple as that” (*Super Meat Boy*, 2011, n.p.). Not surprisingly, allusions to *Super Mario Bros.* abound in *Super Meat Boy*: from the narrative catalyst of the kidnapped love interest (Princess Peach’s kidnapping by Bowser in *Mario Bros.* and Bandage Girl’s abduction by Dr. Fetus in *Meat Boy*), to the existence of “warp zones,” and the levels’ numbering nomenclature (e.g., World 1-1).

*Super Mario Bros.* is not the game’s only point of 8-bit inspiration, however. The cut scene animations introducing each new *Super Meat Boy* world are themselves references to the opening scenes of other classic games including *Ghost ‘n Goblins* (1985), *Street Fighter II* (1987), *Mega Man 2* (1988), *Ninja Gaiden* (1989), and *Castlevania* (1986), among others, with the *SMB* characters—Meat Boy, Bandage Girl, and Dr. Fetus—starring in these re-imagined sequences.

The allusions to classic gaming culture extend beyond each world's introductory cut-scenes to the game's hidden levels and player-characters. These un-lockable levels are modeled after classic games and gaming platforms (such as Nintendo's original, black and white handheld Gameboy device). But *SMB*'s playful, tongue-in-cheek humor is arguably no more evident than with its elusive "Glitch Zone" levels. In these hard-to-reach levels, the screen is made to look like a broken Nintendo game with missing textiles and jumbled text. (Unlike the original NES cartridges, however, you cannot blow into *SMB* to fix the glichy graphics!). Additionally, in a handful of the game's un-lockable "Warp Zone" levels, the gamer plays as characters borrowed from contemporary independent games who sport jumping abilities different from Meat Boy. These colorful characters hail from similarly challenging indie platformers such as *Bit. Trip Runner* (2010), *Mighty Jill Off* (2008) *Jumper* (2004), *Flywrench* (2007), and *I Wanna Be The Guy* (2007). Team Meat's inclusion of these characters gestures that they are as appreciative of retro games' influence on their creative process as they are of the indie game development community of which they are a part.



**Figure 1: Dr. Fetus strikes Bandage Girl in front of Meat Boy.**

*SMB*'s visual design draws playfully upon a hodgepodge of intertextual gaming references. Level after level, gamers are offered visual treats that position them—Team Meat—and us—the gamers—as being hip to insider jokes meaningful to veteran gamers. But these allusions are not the only reason for *SMB*'s nostalgic appeal. In an essay appearing in an anthology on classic gaming, Sean Fenty argues that the lasting appeal of retro gaming is tied to the core, performative nature of games, and that nostalgia is perhaps more pronounced in games than in other media because they require actions which connect the game and the gamer. He notes: "Once we learn the rhythms, we are home—player and game, dancer and dance, one and the same." (Fenty, 2008, p. 22). Later, he continues:

New games continue to evolve increasingly complex and sophisticated graphic, incorporate increasingly complex storylines, and in general offer an interactive space for cinema-like representation. As such, they can evoke nostalgia for earlier days in much the same way as cinema, but with the added allure of interactivity. Video games can represent the past as it was, or as it never was, but they can also represent how players wish to remember it, revisiting or revising the past to make players yearn for it, and they can offer players the possibility of not only *being* there but of *doing* things there – of *playing the past*. (emphasis in original, p. 27)

Experiencing nostalgia in *SMB* is irrevocably tied to playing *SMB*. And playing *Super Meat Boy* means dying in *Super Meat Boy*—a lot. How, then, does a game which kills players quickly and frequently nevertheless engender strong feelings of progress and accomplishment?

### **Super Defeat Boy**

In addition to its playful 8-bit art style and bevy of insider jokes, *SMB*'s negotiation of gameplay difficulty, punishment, and reward hails hardcore and ex-hardcore players alike. The game's level design and the player's progression through its eight worlds and over 300 levels accomplish this feat

in several ways (1). First, with the exception of its “boss battles,” most *SMB* levels are short and can be bested in little time; sometimes in a few seconds (if played properly, of course). (Indeed, completing a *SMB* level with an “A+” rating amounts to a *de facto* “speedrun”). *SMB* also saves the player’s progress, inviting gamers to play the game in brief sessions and to revisit previous levels to attain better times. Games scholar Jesper Juul observes that this issue of time investment is one of the key differences between casual and hardcore game design. Juul (2010) notes:

A common complaint is that life with children, jobs, and general adult responsibilities is not conducive to playing video games for long periods of time. The player that at one time was a stereotypical hardcore player may find him or herself in a new life situation: still wanting to play video games, but only able to play short sessions at a time. Many players of casual games are such ex-hardcore players ... they probably still have the same taste in fiction, but are unable to invest large amounts of time in playing games. (p.51)

Like the ability to save, most of *SMB*’s levels possess a tiered reward structure that encourages repetitive play in the form of hard-to-reach or un-lockable items. Somewhat paradoxically, this design choice makes *SMB* more *accessible* because it allows for different degrees of participation (i.e., making the game more “casual”), and *deeper* because it rewards the player for investing the time needed to overcome difficult challenges (i.e., making it more “hardcore”). For the casual player, *SMB*’s simple and short level designs are easy to understand and give quick, effective feedback. And because the beginning levels are mostly brief, players can play through them over a short period time. The hardcore player, meanwhile, can approach these same levels with an eye toward unlocking the game’s secret characters, discovering the elusive warp zones, and earning “A+” level completion times. The game serves as a brief distraction for those looking to play only for a few minutes, or as a treasure trove of challenging rewards for those wanting to showcase their bona fides as skilled and dedicated gamers.

One of the more inspired and gratifying design choices accompanies the successful completion of each level. Once Meat Boy reaches Bandage Girl, triggering the end of the round (whereupon she is re-kidnapped by the evil Dr. Fetus every time), the gamer is treated to a replay of all their previous attempts at the level. This cumulative replay brilliantly unfolds along a single timeline, transforming the screen into a veritable fireworks display of leaping and splattering Meat Boys. Beyond its visual power as spectacle—which, for the record, should *not* be underestimated—these replays (again, featured round, after round, after round) remind the player that their hard work and perseverance have not gone unrewarded. Gamers also come to realize while watching these comically horrifying replays that *SMB*’s levels are tightly scripted affairs; that they are challenging but not impossible puzzles (though they might seem so after the first dozen tries). The advanced levels are so meticulously engineered and demand such precise input, that *SMB* feels more like a rhythm-puzzle game than it does an action-platformer.



**Figure 2: A torrent of meat boys on parade in a post-level replay.**

And this is where *SMB* parts ways with so many other classic and classically inspired platformers. The game is difficult—painfully so at times—but it is not unpredictable. *SMB*’s levels are complex, but

they are not malicious. And *SMB* is demanding, but it permits gamers of different skill levels and time commitments to traverse its deadly platforms in ways that complement their play styles and lifestyles. Team Meat's Edmund McMillen lamented the state of difficulty in today's games, and commented on their way of addressing this problem, stating:

Difficulty has kind of been thrown out the door and replaced with accessibility over all else, erasing any real challenge. It was vital for us to bring back the difficulty of the retro age, but also reinvent the idea of what difficulty meant. Frustration was the biggest part of retro difficulty and something we felt needed to be removed at all costs in order to give the player a sense of accomplishment without discouraging them to the point of quitting. At its core, this idea was quite basic: Remove lives, reduce respawn time, keep the levels short and keep the goal always in sight. On top of these refinements, we added constant positive feedback, and even death became something to enjoy when you knew that upon completing the level you would be rewarded with an epic showing of all your past deaths. The replay feature was a way to remind the player that they were getting better through their own actions and reinforce that feeling of accomplishment of doing something difficult and succeeding. (*Super Meat Boy*, 2012, n.p.)

But the real issue, as Juul correctly notes, is less about difficulty *per se* than it is about "how the player is punished for failing" (2010, p. 42). In an essay on difficulty in games, Juul (2009) strikes this distinction between failure and punishment: "Failure means being unsuccessful in some task or interdiction that the game has set up, and punishment is what happens to the player as a result" (p. 237). Juul posits these four categories of punishment:

- (1) Energy punishment: Loss of energy, bringing the player closer to life punishment; (2) Life punishment: Loss of a life (or "retry"), bringing the player closer to game termination; (3) Game termination punishment: Game over; (4) Setback punishment: Having to start a level over and losing abilities. (p. 238)

*SMB*'s lauded difficulty is mitigated by its uniquely balanced punishment system. Meat Boy is a valiant but fragile hero who is killed with a single hit or misstep. Or, using Juul's labels, the game's "energy punishment" is absolute and severe. However, when the player dies, she is instantly respawned at the beginning of that specific level without having to sit through any protracted death animations or suffer the inconvenience of restarting at the beginning of that world. There is also no cap on player lives (i.e., "game termination punishment"), and no stripping the player of abilities or forward progress (i.e., "setback punishment"). This means that with the exception of the "Warp Zone" bonus levels (where there is a strict allowance of three lives), players only return to the main menu when *they* decide to give up on a level.

*SMB*'s difficulty-punishment design balance and its levels' tiered challenges (from one level to the next, as well as the reward structure within single levels) conveys to gamers that they are responsible for their accomplishments and failings. The failure to save Bandage Girl rests with the player, not with Team Meat. As Juul observes, "*failure adds* content by making the player see new nuances in the game" (2010, p. 237). In other words, failure in *SMB* generative; it is productive. The game's early stages show players how to sprint, allowing for faster speed at a cost of control, and introduce common platforming moves like the wall jump. Additional elements such as moving obstacles and dissolving floors teach players to think, act, and react quickly. As play continues, the challenges increase in difficulty as players struggle to anticipate where the next safe platform might appear. Misjudging the timing of a leap by a fraction of a second means the difference between threading the needle between two deadly traps, or jumping into a ceiling (or floor) of deadly needles. Of course, all of Meat Boy's moves must be combined to traverse his universe's innumerable hurdles, like deadly piles of salt, walls of saw blades, and other Meat Boy-killing nastiness. And while failure in *Super Meat Boy* is not an asset like sprinting or wall jumping, it is nevertheless an essential feature for deducing the level's logic. After multiple deaths a pattern and rhythm emerge as the stage becomes progressively easier because the player sees the level in its complexity. Punishment is, thus, meted out (no pun intended) in such a way that repeated failures do not inhibit success; rather, the opposite is true. Failures are necessary for success.

## **Super Elite Boy**

Even one of the better-known web advertisements for *Super Meat Boy* is itself crafted in a retro style; specifically, that of a 1990s TV spot reminiscent of the commercials made for the NES and Super NES game systems (see, *Super Meat Boy's 90s Commercial*). This tongue-in-cheek advert reinforces the major themes of *SMB*—that this platformer's playfully parodic content is a loving homage to our collective gaming past. Again, Team Meat's Edmund McMillen on the game's production:

Tommy (Refenes) and I bonded over the course of development, and *Super Meat Boy* was an expression of that. We had fun making this game and didn't hold those feelings back when it came to the decisions we made. *Super Meat Boy* was a schoolyard inside joke that just got out of hand. I think one of the things that is most appealing about *SMB* is anyone who plays video games gets to be in on that joke. (*Super Meat Boy*, 2011, n.p.)

But to understand *SMB* as some glorified joke—as a ludic punch line—is to miss one of the game's more substantial accomplishments. (Please understand that this is not to say that the game is not funny – because *SMB* is *funny*. Indeed, it is fantastically funny at times). The more noteworthy feat is that after enduring countless levels covered with gratuitous streaks of blood and epic replays of cascading and exploding lemming-like Meat Boys, that the game remains endearing and sentimental. Sean Fenty (2008) reminds us of the power of games to transport us through time, saying: “Video games may be, for some, artifacts of a past they want to return to, but video games also offer the seduction of a perfect past that can be replayed, a past within which players can participate, and a past in which players can move and explore” (p. 22). *SMB* presents older gamers with the complex and smart NES-style platformer that they craved as children but never had. And herein lies the game's nostalgic power. *SMB* offers us an illusory trip to a past that never was.

But *Super Meat Boy* is not only about replaying a past that never was. The game likewise assists us with our future platforming adventures, both in and outside of his treacherous world. Juul (2010) argues as much, saying: “The game that successfully manages to get a player to start and keep playing adds to that player's knowledge of conventions. To play a new game is to learn new skills and conventions. The history of games leads up to your playing of an individual game; your playing of that game paves the way for playing future games” (p. 77). With this in mind, we can say that *SMB* is not just a love letter to the games and gamers of yesteryear – gesturing in more and less obvious ways to memorable titles past and present. *Super Meat Boy's* tight gameplay and unique balance of difficulty and punishment works to “reset” the uneven history of platformers by demonstrating that “difficult” need not be synonymous with “unfair,” and that poor design choices are better left in the past.

## **Endnotes**

- (1) As of the writing of this essay, the current PC version contains eight worlds.

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# Chopper versus Chopper

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**Abstract:** The “Chopper versus Chopper” multiplayer game mode included in *Grand Theft Auto IV*’s expansion pack, “The Lost and the Damned” (2009), pits one gamer on a motorcycle against another piloting an assault helicopter in alternating rounds where the pilot must eliminate the biker before the latter scores points by crossing a series of checkpoints. The design of this one-on-one game mode is notable for elegantly distilling a massive and complex synthetic environment into a singularly focused affair between two combatants that fosters competing ways of seeing and understanding their shared space, as well as inciting emergent narratives of narrow escapes and fantastic collisions that draw gamers back round after round.

## A Tale of Two (Liberty) Cities

Player 1:

As I spawn on my rascal of a street bike, leather jacket and helmet strictly for show, the familiar text—“Get to the checkpoints, and avoid the pursuer”—seems ridiculous for what it obscures. The corner HUD map has yet to highlight my shortest route, but I immediately hit the gas and scream up a small incline straight ahead, quickly working my neon green Bati 800 through its gears. You need to be a little lucky to reach any checkpoints at all.

Player 2:

There he is. I can already see him across the city. His avatar’s neon-orange halo makes him impossible to miss from miles away. I gently tip the helicopter forward as its spinning blades make short work of the distance between us. I remain perched at a high altitude. From here, I can see where his motorcycle is headed, and try to anticipate any obstacles that he’ll put between himself and the twin miniguns mounted beneath my aptly named Annihilator helicopter. I make a beeline to his orange halo as his marker zigzags from one block to the next.

Player 1:

Now the yellow line appears and tells me I guessed wrong; I hit the emergency brake, swerve hard left and slam into a protesting, foul-mouthed pedestrian, and then a brick facade with scaffolding, ingloriously tumbling off my ride. This bike’s torque turns pavement into ice.

Player 2:

And now his marker has stopped. I can’t tell whether he’s had an accident, if he’s stuck in traffic, or if he’s luring me into a trap. My Annihilator is fast and powerful, but its size and momentum makes it susceptible to the city’s innumerable architectural elements. Nothing can destroy my gunship. However, billboards, traffic lights, and elevated roads can stop me from stopping him. He scores a point with each checkpoint he crosses. But if I time my approach right, he will not cross the first one.

Player 1:

Remounting, I again push the tiny vehicle to top speed, taking a multitude of wide turns, past warehouses weathered by salt in the air, under power lines and stoplights black against the twilight, and toward an immense silhouette of the suspension bridge that will bring me into the city. By now, he’s probably very close indeed, maybe setting up for his first shot. One last hard corner, and I’m roaring up the freeway entrance ramp.

Player 2:

I’m closing in on him. It’s still early in the round, so there’s no need to announce my arrival with premature gunfire. He is traveling from one of Liberty City’s boroughs to another by way of a four-lane bridge. This will be my point of attack. Once he commits to this route, I drop the Annihilator down and sweep wide to out flank him. If I execute my move correctly, I’ll connect with him as he turns on the bridge’s elbow. My arrogance dissuades me from using my guns. I do not want to shoot him; I want to crush him with my helicopter. I drop from the sky like a celestial hammer, punctuating my sudden appearance with a dignified “AHHHHHHH!”

Player 1:

About a hundred feet over the water, my wheels dance among the dense bridge traffic, flirting with the concrete divider. The world blurs as I tear through the vulnerable rush hour commuters, all apparently oblivious to the immanent threat dangling above us all. I sense rather than see an enormous plunging black mass. I slam on the brakes, and my pursuer plops down ahead of me like a skydiving orca without a parachute, crushing three unsuspecting motorists.

Player 2:

My dramatic belly-flop maneuver misses his bike, but not the adjacent traffic. Nearby cars explode into flames while others are flung off the bridge like ragdolls. As my Annihilator flails about on the blacktop like a mechanical beached whale, I catch a glimpse of the biker careening around the bridge's metal wreckage. He sails through the tollbooth. And though it remains invisible to me, I know that he must be closing in on the first checkpoint.

Player 1:

Weaving sneakily past the deadly (if momentarily grounded) churning rotors, ignoring the chorus of terrified screams, I urge my bike through the sparking carnage. Knowing that my odds have dramatically improved, I tense up a bit – you don't want to make any mistakes if you manage to survive the initial assault. Engine at full-bore, I zip along the highway with a high-pitched whine, for the first time paying attention to where the checkpoint might be. Skyscrapers tower in my field of view, and I allow myself a moment to appreciate the enormity of downtown Liberty City.

Player 2:

The Annihilator is agonizingly slow to right itself. Its blades clip the tollbooth and grind against lampposts. While I struggle to recover from my failed strike, the biker puts more distance between us. Despite his narrow escape, he has not returned to the relative safety of the city blocks – not yet. Having righted the bulky black bird, I push the helicopter forward, firing short bursts at my target. From this distance, I might get lucky and knock him off his bike, or cause a nearby car to sideswipe him. But he and I know that these shots are mostly for show. I'm taunting him, daring him to tempt fate again.

Player 1:

Distant mechanical rattling echoes give way to intense, momentary tremors. Metallic shells rend the earth around me, splashing me with fiery pavement. Somehow maintaining my balance, I rocket toward the exit ramp, and see that the checkpoint is a few short blocks away. I make no decisions about which turns to take; if I don't know exactly where I'm going, neither does he.

Player 2:

With my helicopter now paralleling the roadway, I line up my crosshairs on the nimble biker. I take a few casual potshots, kicking up asphalt and ripping apart the roadway's concrete divider. He hasn't taken any direct damage, but the indiscriminate destruction is cluttering his escape route. He is forced to slow down to negotiate a tight space between two wrecked cars. And that's when it happens.

Player 1:

Wincing in anticipation, I prepare to jump the exit ramp's retaining wall, but the charred hull of a mid-'70's sedan inconveniently slides across the lane and forces an evasion. It's an earthquake of heat and noise all around me. There's a sinking feeling in my stomach as the motorcycle skids to a near-stop, and I briefly consider abandoning it. Now I'm picturing myself sprinting to the wall, leaping over it, and hustling through the tree-lined park on foot, all the way to the yellow-and-black-checkered goal. Of course, I won't ever get the chance.

Player 2:

I lay off the guns and drive the Annihilator down. It strikes the road with a sickening thud. The cars around me ignite instantly. I see the biker frozen in time and space, paralyzed amongst the wreckage. This is when one of my blades catches his torso and flings his summersaulting body into the evening void. My screen fades to gray.

Player 1:

The sports car-turned-fireball throws me up and back from the seat, doubled over, hands and feet out front of me, my body concave to the street. I might have flown fifty feet backwards if the blades hadn't

caught me; I might even have survived. Instead, they strike the rear panel of my leather jacket squarely and bend me convex. Like a batted ball I instantly reverse direction, which is how I go flying across the park—five, ten stories up—lazily twirling over the autumn trees at sunset.

Player 2:

My opponent's sudden death is accompanied by a discordant sound—his howling laughter. This is not our first match, and it will not be our last. The game reorients my point of view, and the roles are reversed. I am now sitting on a motorcycle lost somewhere in the city. It's now my turn to get through the checkpoints. I should get going. After all, somewhere nearby there is an indestructible helicopter bent on my destruction. And I am sitting here with a bright orange target on my back.



Figure 1: Player 2 chases Player 1 in “Chopper vs. Chopper.”

### **“It was the best of choppers, it was the worst of choppers”**

“Chopper versus Chopper” (CvC) is one of several multiplayer games packaged with “The Lost and Damned” downloadable expansion pack for the 2008 multiplatform action-adventure game, *Grand Theft Auto IV* (*GTA IV*). A critical and commercial success, *GTA IV* built on the design formula that has characterized the series: open-world gameplay, urban spaces teeming with colorful citizens and vehicles, and a rags-to-riches story that allows players to make narrative choices that determine the game’s outcome. But unlike its predecessors, *GTA IV* was the first to feature multiplayer gameplay. The core game came equipped with a suite of modes, including “team deathmatch,” car races (both armed and unarmed varieties), and cooperative missions, among others.

*GTA IV*’s two expansion packs – “The Lost and the Damned” and “The Ballad of Gay Tony”—allowed players to revisit the game’s NYC-inspired locale, Liberty City, through the eyes of different protagonists. These add-ons also introduced new multiplayer modes, including “Chopper versus Chopper” (CvC).

At first blush, CvC can be an underwhelming experience. This is especially the case when the game is viewed alongside the random, free-flowing violence of “Free Mode” or the frenetic, Mad Max-like armed road battles of “GTA Race.” For one, the number of competitors is dramatically reduced. In lieu of competing hit squads, only two players inhabit this world. And these two players are not offered a wealth of in-game options. One player begins on a bike, and the other one in a helicopter. The former chooses the best route to the map’s checkpoints, while the latter works to eliminate their competition. But CvC is not any less of a game mode because of its restrictions; it is a more compelling experience because of them.

CvC’s rules distill *GTA*’s synthetic boroughs filled with scheming, player-controlled would-be mobsters and hapless non-player characters into a singularly focused affair between two combatants. Notably gone are multitudes of players vying for first, second, or third place in some road race. Gone are the solipsistic snipers that take opportunistic shots as you scramble to find cover. And gone are the rocket-propelled grenades that make short work of your team’s get-away car. More subtly, though no less importantly, absent is any context for the conflict. The pilot is not urgently preventing a briefcase handoff; the biker has no drug kingpin to identify. There is no justifying backstory, no narrative excuse required, and what remains is the sheer exuberance of the toys and map.

To be clear, it's not as if the "kill or be killed" logic that undergirds the vast majority of AAA games or even *GTA*'s other multiplayer modes is absent here. Indeed, in alternating rounds, one player is tasked with eliminating the other in spectacularly violent fashion. CvC is likewise not alone in gifting a single player with different game assets (e.g., weapons, armor, vehicles, information) from others to create unique gameplay dynamics. But CvC regulates considerably the terms of its contest, and in doing so presents its two players with dramatically alternating perspectives of this sandbox style city—one from a cockpit above, and one from a leather seat below—that showcase this mode's elementary but essential brilliance.

The alternating perspectives of CvC accomplish elegantly what few other video games are capable of doing. The game establishes competitive gameplay balance by presenting two players with wildly differing perspectival, spatial, and gameplay resources. That is, whereas most competitive games create parity via a series of equivalences—literally staging an "even playing field"—where each side is granted balanced abilities and resources, CvC is an exercise in ludic dissimilarity. For example, the Annihilator pilot can rain down hundreds upon hundreds of bullets in endless waves on the vulnerable motorcyclist. The agile biker's primary strength (such as it is) is her maneuverability. By jetting between the shadows of the city's buildings and overpasses, the biker hopes to force her opponent to guide their bulky and unwieldy gunship through a thicket of urban architecture, occupying them long enough so the biker can score an elusive point. Both choppers must time their approaches with the other player *and* the city in mind. Can the biker risk prolonged exposure on the open bridge? Should the pilot hang back and assume a better firing position, allowing the biker the time to score another point? Even the title's wordplay gestures at the false equivalences of this urban battlefield. That is, while "chopper" is a recognized nickname for both vehicles, at no point does the game feature two competing helicopters or motorcycles (1).

Clearly, the helicopter's spatial freedom—its ability to play in three dimensions—grants it substantial advantage over the earthbound motorbike. But it is the Annihilator's indestructibility, the mode's most overt suspension of physical reality, which mercifully guarantees that the predator vs. prey calculus neither approaches true gameplay parity nor earthly realism. (To be sure, the biker who crosses multiple checkpoints during any single round has beaten long odds). Striking this unique imbalance between combatants ensures that the mode is understood as a fantastic game and not some horrific simulation (i.e., this "cat and mouse" game mode is the obvious by-product of *GTA*'s sandbox world; it bears no connection to *GTA*'s gritty narrative or its attendant physics). This is a gamble and sacrifice that pays off; the invincible pilot and the nearly powerless biker experience heightened emotional states as a result of this radical inequality (2). While the "choppers" literally move the players around Liberty City, the disparate manner in which they do so makes them affective transports, too. The roles and attendant machines impart dispositions to gamers traveling though the city either the proud and haughty Annihilator pilot, or the terrified and wily biker, thus "moving" the players emotionally.

In this manner, the revolving rounds of "hunt or be hunted" gameplay allow players to see and traverse Liberty City's space and physics in diametrically opposed ways. And with a change in the player's position and abilities comes a change in gameplay strategies (e.g., the biker's utilization of evasive maneuvers, the pilot's strategic use of firepower, etc.). Functionally speaking, this amounts to little more than moving from offense to defense. One player is the under-equipped scorer, the other player is the overpowered goalie. But oscillating from one vehicle to another generates a wellspring of gaming pleasure because CvC also presents its gamers with competing modes of experiencing and knowing Liberty City's complex environments and spaces. In other words, built into these alternating perspectives of biker-pilot-biker-pilot are competing experiential and epistemological frameworks. The Liberty City you zip through as the biker is not the same city you surveil and assault as the helicopter pilot. The same skyscrapers that shielded you from gunfire last round are now making it impossible for you to eliminate your competition. With each round, the city transforms from offering contextual affordances to liabilities.

The pleasure of any one round's situated knowledge is reinforced and amplified by the mode's other prevailing pleasure: imagining your opponent's point of view. CvC's ludic alterity is born out of the identity swapping between the "choppers." The game designers are not blind to this fact. Indeed, when the helicopter closes on her prey, the biker is momentarily gifted (with the press of a button) with the ability to see the world from her opponent's vantage point (note: there is no similar ability for the pilot since the biker's location is perpetually announced with the several stories-high neon orange

marker that is affixed to that avatar). This new point of view typically assists the biker in escaping the nearby Annihilator. However, if the players are chatting with one another, the pilot can tell the biker to switch to that optional view to witness their demise from the pilot's cockpit, perversely turning the biker's asset into a *de facto* "kill cam."

Let us return to the scene of the crime on the decimated causeway. That particular altercation was the finale of but one of many, many rounds. It also marked the end of two emergent stories that had, only moments before, started as separate Liberty City narratives. The collision of the biker and the pilot's strategies and choices on the bridge is likewise a narrative confrontation. But unlike a cinematic chase scene that reveals space and distance through careful editing choices, CvC players must imagine the other player's storyline and choices before they find one another. And therein lies a great deal of the game's holding power.

This interplay of distinct but interconnected narratives, incited by a simple gameplay mechanism and set against a stunningly complex backdrop, constitutes a more direct, visceral, and—indeed—intimate communication than many other competitive gaming modes. The focused interplay between radically different chopper experiences of the same virtual space and series of events has interesting educational possibilities. Imagine how players might think about personal, historical, and fictional narratives and discourses if they could experience a space and/or event from oppositional viewpoints with oppositional agendas. This simple game construct enables a rapid-fire exploration of competing worldviews with quick entries and stunning exits.

Moreover, instead of growing increasingly tiresome, the simple CvC setup grows richer with each round. But why? The mode's holding power is partly due to the enormity of the city map which takes time to master. It is also owed to the city's randomly spawning denizens and traffic patterns, which create new surprises with each replay. But the strongest attraction of CvC is predicated on the players' ability to contribute to their emergent two-player narrative (with all the attendant pleasures and obligations) and the situated knowledge of traversing an expansive space with radically different transports and conflicting *modi operandi*.

The magic of CvC hinges on its transformation of a simple but satisfying gameplay dialectic into the promise of as-yet unwritten but memorable stories of narrow escapes and destructive collisions. That is, the mode's ludic alchemy converts violent spectacle into an ongoing narrative of violence. And while the game's basic scoring mechanic of one point per checkpoint baits the biker out of the shadows and into the vulnerable night despite the comically overwhelming odds set against him, it is the mode's emergent and intertwined narratives and points of view—it is the pitting of one Liberty City tale against another, told by Player One to Player Two and back—that promises that the potential reward is well worth the risk and keeps gamers engaged round, after round, after round.

## Endnotes

- (1) CvC differs greatly from standard "capture the flag" constructs where players temporarily enjoy different abilities or powers. Take, for example, the popular Oddball gameplay mode in the *Halo* series. A multiplayer variety of "cat and mouse" with shifting roles, Oddball grants points to a player in possession of a skull, simultaneously altering their offensive capabilities. Yet CvC departs from this more popular formula by locating its players in radically different relationships to the game space, and by amplifying its combatants tremendously uneven odds. These design choices result in a substantive narrative reset after every kill.
- (2) At some point over the course of dozens if not hundreds of such engagements, the biker will find himself on foot and at an even greater disadvantage. Having been knocked off his motorcycle, the biker faces the hovering Annihilator. Mostly in jest, he will pull out his pistol, and wildly fire at the helicopter's tiny window. Both players delight and rejoice in the discovery that the bike-less biker can actually wound the pilot sitting in the indestructible helicopter.

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Figure 1. Image captured from GTA Multiplayer.pl: Retrieved from <http://gtamultiplayer.pl/en/tlad/multiplayer/>



# Well Suffered

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**Abstract:** This well played session explores the challenges and difficulties experienced by the author while playing the indie platformer Super Meat Boy over the course of more than a year. The author juxtaposes his own played experiences of failure and frustration with the suffering endured by Team Meat, the game's developers, during its production. The acts of playing difficult games and producing an independent game are of course different. However, as instances of self-inflicted suffering, the development experiences of Team Meat and the experiences of its players both provide interesting opportunities to examine phenomena of failure, learning, work, and play. Over the course of a selected playthrough of the game, the author will explore the themes of failure, suffering, & triumph woven into Super Meat Boy through game mechanics, narrative, and art, and how those themes both echo the developers experiences and advance one understanding of learning in games.

## Introduction

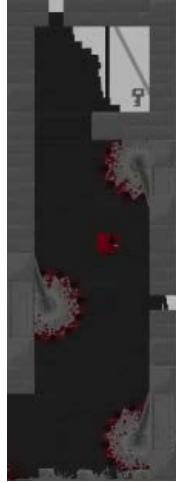
At the Game Developers Conference (GDC) in 2011, independent game developers Edmund McMullen and Tommy Refenes, collectively known as Team Meat, presented a post mortem of their extremely successful 2D platformer Super Meat Boy. This post mortem was somewhat out of the ordinary for three reasons. First only Edmund was physically present with Tommy calling in via video-conference. Second, rather than calling the session a post mortem, the two chose to give it the slightly enigmatic title "Super Meat Boy: A Team Meat Meatmortem." Third, and most relevant for our consideration of the game, the session focused extensively on the incredibly difficult challenges Team Meat experienced in completing Super Meat Boy and bringing it to market. These challenges were in fact so brutal that in reporting on the conference session, the video game blog Joystiq subtitled their report "The almost death of Team Meat" (Hinkle, 2011). While this might be mistaken for a piece of journalistic hyperbole, it actually directly reflects statements made by Tommy Refenes both during the Meatmortum and since that it would have killed him if they'd tried to release the game on more than one platform at once (McMullen & Refenes, 2011).

I had purchased Super Meat Boy on Xbox Live roughly four months prior to GDC 2011, and clocked a substantial number of hours by that March. I was far from finishing the game at that point, but I had already died countless times. Dying repeatedly is in some sense one of the core mechanics of Super Meat Boy. Although it draws direct influence from Super Mario Brothers (1), unlike Mario and most other classic platformers, the player has an endless number of lives. Levels are generally rather short and a skilled player can complete most of them in seconds. However, many levels are extremely difficult and as a result most players die dozens of times on a moderately difficult level, and even hundreds of times on the most difficult levels. The magnitude of completing a particularly difficult level is also visually enhanced as on completion of a level, the player gets to see all of their attempts at completing the level play simultaneously (see Figure 1).



*Figure 1: A replay of a level where the player died many times*

As I write this, I still haven't completed the game although I am very close to its technical end (2). In fact as I write this I am stuck (and have been for months) on a level titled Omega. It is the last level before the final boss fight in the game. The part of Omega on which I'm stuck involves gently guiding Meat Boy over the edge of a cliff and down between some saw blades. I can get up the cliff to get the key easily enough, but apart from one time, I've been unable to get back down.



**Figure 2: The drop I'm stuck at on Level 6-5 “Omega”**

Coming back to GDC 2011 and the Meatmortem, I can't recall precisely where I was in the game at the time, but I had definitely been playing it with some frequency. It's extremely likely that I was stuck on one of those parts of the game that tends to cause me to swear extensively, hop up and down in frustration, and nearly hurl the controller across the room. Indeed, by the time I found myself sitting in that hall at Moscone Center listening to Team Meat discuss the suffering they endured in developing Super Meat Boy, I had already experienced a significant number of rage inducing moments while accidentally hurling Meat Boy's tiny red body into grinding gears, rotten meat blobs, or any of the other countless perils and enemies that can be found throughout the game. Sitting in that hall surrounded by game industry professionals and aspirants, I couldn't help but draw a connection between the suffering experienced by Team Meat in creating Meat Boy, and the more modest suffering experienced by players like me in playing it. As a games and learning researcher, I also found myself thinking about other instances in games research where boundaries between work and play have been observed to blur (Dibbell, 2006; Malaby, 2007; Yee, 2005), and about the theory posited by Roger Schank on how learning takes place through expectation failure (Schank, 1990). When I subsequently began to replay earlier portions of the game, I was excited to find that these same themes were not only instantiated as played experiences through game mechanics, but enhanced and extended through narrative design and art direction.

### **From The Forest to The End**

Super Meat Boy is composed of seven different worlds, plus a "world" that is updated periodically with additional content called "Teh Internets." Most worlds contain twenty levels and a boss fight, and on each level the player's job is to help Meat Boy rescue his girlfriend Bandage Girl who has been stolen by the evil Dr. Fetus. The core of the game consists of the first six worlds called: The Forest, The Hospital, The Salt Factory, Hell, The Rapture, and The End. The sixth world, The End, only has five levels, and the seventh world "Cotton Alley," has the player play as Bandage Girl rescuing Meat Boy and can only be accessed after beating all of the boss fights on the first six worlds. The remainder of this paper will explore a few of the worlds of Super Meat Boy offering a consideration of how the game progresses through stages of difficulty, supports a theme of suffering through its various design elements, and how that theme frames the process of learning to play the game. When relevant, I will also bridge to the topic of the development experience related by Team Meat during the Meatmortem at GDC 2011 and in subsequent publications.



**Figure 3: Super Meat Boy World 1 Level Selection**

### The Forest

Super Meat Boy begins in the pastoral environment of The Forest. The color palette of the intro scene and many of the early levels is dominated by soft browns and greens, and 8 bit squirrels and other forest critters. While it's immediately evident to the experienced player that the game is a precision platformer based on the sensitivity of the controls, Team Meat eases you into that difficulty by providing a classic structure that uses the first several levels to orient the player to the basic controls and types of challenges Meat Boy must face. The first actual danger the player faces is on level 1-3, The Gap, in which the player can accidentally guide Meat Boy into the titular gap plunging him to his doom. Giant saw blades are a persistent hazard throughout the game, and they are visible from as early as level 1-2 giving the player the suggestion of danger, however the blades aren't actually exposed until level 1-6. In short, the early levels of Meat Boy are designed to make the player comfortable with the basic platforming activity that will drive the rest of the game. Clickable signs are even deployed across the first few levels to provide the player with basic hints about the nature of the challenge on each level and how it can be overcome with the appropriate controls.

Prior to picking up Super Meat Boy, the “hardcore” 2D platformer wasn’t exactly a style of game that I’d spent a huge amount of time with. While I’d certainly played a number of the Mario games over the years and had completed Braid in 2010, I’d never devoted any real time to any of the hardcore precision platformers like Mega Man or Ninja Gaiden. Among other things, while I grew up with a computer at home from the late elementary grades on, I didn’t have a game console in the house. Since the console with game pad style controllers has historically been the natural setting for platformers, this meant that the genre as a whole wasn’t one that I had a particularly deep history with.

That said I knew what I was getting into when I purchased Super Meat Boy. Since I began studying video games I’ve made a point of trying genres that are outside of my comfort zone, and to some extent Meat Boy was just a continuation of that approach. Putting all of this together, the beginning levels of Meat Boy did exactly what they needed to do for me as a player. They got me comfortable enough flinging Meat Boy’s body around the screen that by the time I got to level 1-8, the first level where I encountered a challenge that gave me any kind of difficulty at all, I was ready to press on. In fact, Team Meat does an interesting little trick right before 1-8 with level 1-7 as it introduces an element visible in the upper right corner of Figure 2 (a saw blade that requires a relatively long wall jump to surpass) that appears extremely difficult upon first viewing, but is actually relatively easy. This prepares the player for future challenges by offering an opportunity to realize that even elements that might appear difficult or impossible are ultimately beatable.



**Figure 4: Super Meat Boy 1-7.**

The trick of warming the player up to a state of relatively fluid play and then producing a difficult level that the player has to push through is one that Team Meat employs several times in world 1. I experienced these sorts of choke points in The Forest on level 1-15 which combines collapsing walls and saw shooters, and 1-19 which is the longest level in The Forest. 1-19 was actually difficult enough that even on the playthrough I did recently in preparation for this paper I died several times.

Each world only requires the player to complete 17 of the 20 levels in order to unlock the boss fight. When playing The Forest initially, I played through and beat all 20 levels before getting to the first boss Lil Slugger, a bipedal robot with a chainsaw attached to the front that Dr. Fetus drives across the level chasing Meat Boy through a series of perilous obstacles. I have to count Lil Slugger as the first legitimately difficult challenge in Super Meat Boy. In fact, I actually paused for a second before starting the level on my most recent replay. For just a moment I was struck by a feeling akin to fear, the memory of my first attempt at Lil Slugger looming large in my imagination.

Overall The Forest provides the player with an opportunity to generally get adjusted to how Super Meat Boy plays, and to some degree to inure the player to the experience of repeated death and the accompanying frustration that will characterize the rest of the game. There are minor challenges, but even a modestly competent player of 2D platformers like myself doesn't experience much in the way of frustration or suffering on a first play through of The Forest. I see a parallel here that probably applies to the development path trod by Team Meat, and that certainly applies to my own experiences in game development and other large-scale projects. In essence, the work starts out as a joyful experience. You might encounter a few early difficulties, but the activity is fresh, exciting, and generally filled with promise. While you anticipate some trials ahead, you don't truly have any notion of the scope of those actual challenges. This is the point where your emotional investment in the process is relatively high and your material investment relatively low.

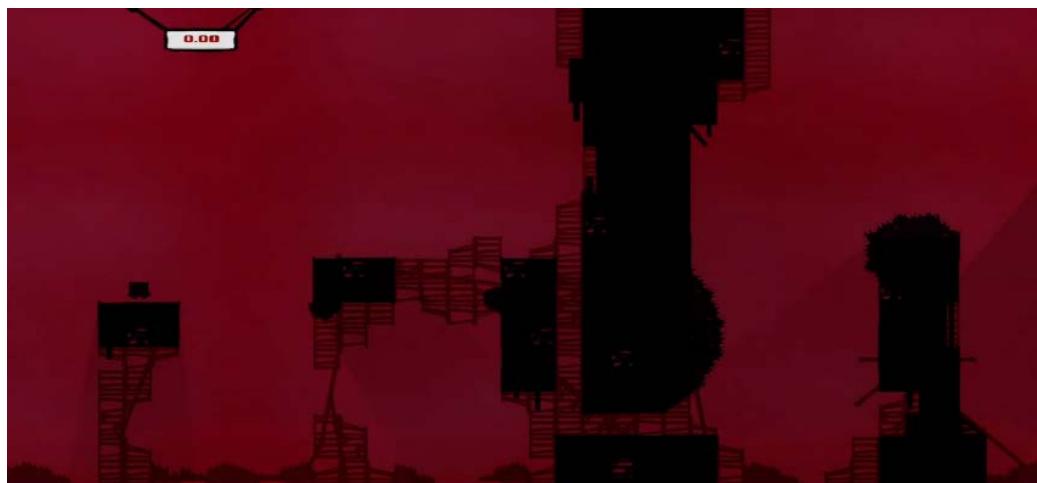
For all of the positive feelings that the early levels of Super Meat Boy invokes, the conclusion of the boss fight with Lil Slugger provides a sharp counter point, and a clear reminder that this game is not really about relaxing and having a good time. After the completion of the level, a cut scene is triggered in which we see that the forest is on fire. The entire palette has shifted to red and black, and at the start of the scene we see Dr. Fetus escape to the next world taking Bandage Girl with him. Everything is burning and there are literally piles of dead squirrels strewn about. It is a scene of absolute pathos as a surviving squirrel surveys its dead kin only to turn and look at Meat Boy with tears streaming down its face. Of course, Super Meat Boy never takes itself too seriously. The melodramatic nature of the scene is promptly cut short as the squirrel is decapitated by a flying saw blade, and the player is pushed on to the next world.

### **The Hospital**

The second world in Super Meat Boy is The Hospital, and everything about the design of world two tells the player that things are getting significantly more serious. While I still managed to one shot the early levels of The Hospital on my second playthrough, I found that I was gritting my teeth on occasion and had to remind myself to breathe. Beyond the general increase in difficulty, The

Hospital's shift in mood is supported by a major change in aesthetics. The palette shifts over primarily to dark purples, blues, and greys. In supporting the theme of an abandoned hospital, the landscape is littered with piles of broken syringes that, like so many things in the game, spell instant death for Meat Boy. While I haven't mentioned the music thus far, it too is an essential part of the Super Meat Boy experience. Danny "B style" Baranowsky is the musician behind the Super Meat Boy soundtrack, and his work perfectly supports the evolving mood of the game. While the music for The Forest is generally light and upbeat, the music for the Hospital takes a very rapid turn in a darker, spookier direction (4).

World two also pulls from the pages of classic game design by introducing a much wider array of features into the game's landscape. Giant fans are introduced starting on level 2-4, and while the player often needs to use these to propel Meat Boy to different parts of the level, a chance encounter with one can also shred him in a meaty mess. On level 2-7 Meat Boy has his first encounter with a staple of 2D platformers, moving enemies. While I found the complexity introduced by these variations presented very little challenge on my second playthrough, I can well recall the rising frustration I experienced the first time through. Team Meat very carefully introduces new elements into the game, usually presenting them first in isolation, and then in various combinations that force the player to adapt. Moving enemies in particular create a dynamic where the player has reduced opportunities to pause throughout the level. Level 2-13 introduces floating enemies that bounce around the level magnifying this issue further. Like the wall jump with the saw on level 1-7, the technical challenge posed by these enemies is no where near as significant as the psychological impact on the player upon first encountering them. Perhaps an even better example of this effect is evident on level 2-8. As you can see in Figure 3, this level shifts to a silhouetted view with a reddish background. There is nothing about this shift that makes the level harder in any technical sense, but the dramatic aesthetic shift definitely impacts the player's impression of the level's difficulty.



**Figure 5: Super Meat Boy 2-8.**

That said 2-8 is a comparatively difficult level. It was somewhere in this vicinity that I began experiencing serious frustration with some levels, sometimes playing until my hand began to hurt from gripping the controller too tightly, or stopping when I was on the verge of throwing the controller across the room. I should note at this point that I've never actually thrown a controller while playing a video game or under any other circumstances. However, as anyone who has encountered moments of extreme difficulty in a game likely knows, the temptation to do something physical in these instances of extreme frustration while gaming is a very real one (5). It is in large part the depth of frustration blended with the persistence that many gamers approach these moments with that has lead me to frame the experiences of playing a game like Super Meat Boy as a form of self-inflicted suffering. It certainly defies our normal framing of gaming as a fun activity, and arguably pushes on the boundaries of "hard fun" as used by various game designers and scholars (Koster, 2004; Papert, 1998).

### The Rapture

I'm not quite sure how long it took me to traverse the levels between The Hospital and The Rapture. I know that I was stuck for various periods of time on several levels in between the two, including the particularly brutal boss fight at the end of World 3, The Salt Factory. That said I know I began to get

into a certain kind of rhythm with Super Meat Boy in those intervening levels, and that this same rhythm applied to my experience with The Rapture as well. I would get to a level and I would get caught up on some particular challenge in it. I would be stuck on it for days if not weeks. I played lots of other games during this time, but I'd keep coming back to Meat Boy. This was also the point where I started replaying more levels, or pursuing some of the alternate content available by unlocking Dark World levels (see end note 2). Then, one day I would pick up the controller and either start a level I was stuck on, or try it after warming up on a few other levels and whip right through it in just a few attempts.

This moment of picking up the controller and suddenly making magic happen on the screen after hours of frustration and defeat is of course the core experience that forces questions of learning into the spotlight. Too often in discussing learning in the context of education we look for ways to make learning easy. Yet, the moments players experience in games like Super Meat Boy where success and in some instances even understanding rest on the result of repeated failure offer a sharp counterpoint to the whole enterprise of making learning easy and safe.

This is not to say that learning only happens when this sort of "limbic" response is engaged, but rather that there are certain types of learning that seem to rely on repeated opportunities for failure, and it is more or less inevitable that when educating humans repeated experiences of failure are bound to bring about some moments of frustration and potentially even suffering. There are of course other factors that we can consider in this context. While there is debate on whether "unconscious thought" is an effective aid in decision-making (Newell, Wong, Cheung, & Rakow, 2009), it might be that failure and its emotional consequences are not as relevant as the process of taking time away from the cognitive task represented by something like a difficult game level.

Still, it is hard to shake the idea that difficult experiences can be particularly impactful and as such, for better or worse, result in experiences that stick with the learner. It is for this reason that Roger Schank's concept of expectation failure (1990) seems to also fit with the learning that takes place during difficult moments in game play, and perhaps also in the context of learning both the technological and sociotechnical constraints that impact processes of design and development. Certainly Team Meat encountered some particularly stressful moments in the process of creating Super Meat Boy, and the learning that they experienced as a result of that process has had a powerful effect on how they have approached the process of game development subsequently. While this is distinct from the moments of expectation failure that I experienced in playing Super Meat Boy, both represent experiences that didn't fit our existing scripts for the challenges we faced. Both instances offer us an opportunity to observe learners being forced to produce solutions that were novel in relation to prior experiences.

## **Well Suffered**

I almost titled this paper Well Failed, as it is the moments of failure that lay the bedrock for ultimate success in both working through difficult levels in an extremely hard game, and in the process of creating a complex artifact like a game. After all, the whole point of iterative development processes is to find the weaknesses in the product and create a better result by improving those failed elements in the next iteration. In this respect failure should certainly always be seen as a learning opportunity. However, in thinking about Meat Boy I ultimately keep returning, in a manner I hope is neither particularly Sisyphean or Nietzschean, to the theme of suffering.

While I can only hope that the level of suffering Team Meat had to endure in developing Super Meat Boy was not technically a necessary experience for deriving either the quality of game they produced, or the depth of learning about game design and the game industry that they received in the process, I cannot help but wonder if some degree of the adversity they experienced was at least somewhat beneficial. Or perhaps this is just the narcissistic tendencies of the academic, seeking to justify the value of the tribulations I and others have experienced over the course of the doctoral accreditation process by attributing value to the suffering endured by game developers whom I admire.

While I'm willing to acknowledge this possibility, it doesn't ultimately have that much bearing on my played experience of Super Meat Boy. While I have yet to beat the game, and may never actually complete the core content, I ultimately regard the frustration that I have experienced while playing Super Meat Boy as a relatively small price to pay for the intense feeling of fulfillment that I have had in those moments of success that attend the completion of an extremely hard level. Even more

importantly, I see in those moments of frustration and failure moments where I have come to understand something about myself as a gamer, and as a learner.

## Endnotes

- (1) In discussing the design influences of the game Edmund McMullen specifically cites Super Mario Brothers stating that the guiding design principle he and Tommy utilized for Super Meat Boy was re-imagining Super Mario Brothers in the present games market.
- (2) As explained in the second section, Super Meat Boy contains a range of content that extends play beyond the core of the game. In addition to the inclusion of the Cotton Alley levels and the expanding world called Teh Internets, every level in the game has a hidden hard mode (called dark world) that is unlocked after the player has earned an A+ by completing the level. On top of this, there are also hidden warp zones in the game, and there is also the community driven Super Meat World which contains player generated content and is only accessible on the version of the game for Windows and OS X.
- (3) The talk and the full paper will offer an exploration of the entire scope of the game including the worlds not included in this proposal.
- (4) I actually liked the music for Super Meat Boy so much that I purchased a copy of the double disc *Nice to Meat You* when Baranowsky released it in January of 2011 and listened to very little else in my car for approximately 6 months. If you like video game music at all it really is a very compelling soundtrack.
- (5) A great amount of research has been directed at the topic of depictions of violence in video games and aggressive or violent behavior. I believe that on a fundamental level this research is missing the obvious connection between video games (and games in general including sports, board games, and everything in between) and any kind of aggravated or irritated state the player experiences. Rather than looking at the imagery presented in games, it would likely provide researchers with far more direct understanding of these sorts of responses if they focused on the degree of difficulty or frustration (e.g. stress) that the player experiences while playing the game as the covariate in predicting aggression.

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## **Worked Examples**



# “Critical Interactives”: On the Origins of a Concept

Duncan Buell and Heidi Rae Cooley, University of South Carolina

**Abstract:** In June 2010, the University of South Carolina hosted a NEH-funded Institute for Advanced Topics in the Digital Humanities focused on serious games in the humanities. The three-week summer intensive proved pivotal. It established an interdisciplinary team that has [or who have] obtained subsequent NEH funding for the development of a social history game, *Desperate Fishwives* (DF), inspired by HGI participant Dr. Ruth McClelland-Nugent (Augusta State University, GA). A functioning prototype of DF will be play-tested in McClelland-Nugent's classes in Spring 2012. Work on DF has proceeded in tandem with a cross-College team-taught course called “Gaming the Humanities,” and a second project, called “Ghosts of South Carolina College” (GSCC), has emerged from this pedagogical experiment. The authors present the worked example of DF and GSCC as distinct moments in a process that has led to rethinking “serious games” in terms of “critical interactives.”

## Context: Humanities Gaming Institute [HGI] at University of South Carolina

As representatives of the University of South Carolina, Columbia, South Carolina, we, along with faculty colleague Simon Tarr, were delighted to hold an intensive three-week institute on gaming for the humanities held 7-25 June 2010 and sponsored by a National Endowment for the Humanities Institutes for Advanced Topics in Digital Humanities grant. Called the Humanities Gaming Institute (HGI), the institute aimed to reduce the technical barriers to the adoption of gaming as a research and teaching platform by: (1) educating participants about the theoretical and methodological issues of gaming; (2) providing hands-on experience in existing games; and (3) designing new games based on participant ideas. Solicited from a national call listed on the NEH Office of Digital Humanities website, a total of 22 participants were selected from twelve states representing diverse disciplinary backgrounds. The participant pool, which included graduate students, junior and senior faculty, and community members, were guided by HGI personnel and three invited expert speakers/discussion leaders, each of whom served as a week-long consultant.

The Institute was structured around three themes. The first week's theme was “making and playing” and had, as guest consultant, technohumanist and cultural theorist Anne Balsamo from the University of Southern California. The second week's theme was “designing play,” with game designer Tracy Fullerton, also from the University of Southern California, as the speaker-consultant. The third speaker-consultant was game designer and theorist Ian Bogost from Georgia Tech, who headed a week geared toward “effective play.” Readings and subsequent discussions drew from the guest experts' scholarship and practice and were intended to benefit the proposals put forth by participants. In the first week, presentations for a non-specialist audience were made by USC students and faculty on Flash programming for gaming, on iPhone programming, and on Android programming, with the intent to familiarize participants with the three major technical trends in gaming development. Likewise, the three weeks offered--both formally and informally--opportunities for a variety of play across diverse medial platforms (e.g., cards, board games, hopscotch, videogames, etc.).

## Prototype: *Desperate Fishwives* [DF]

In week three, Institute participants presented concepts for developing a humanities-oriented game. We assessed the various proposed projects to determine which could be advanced. We were committed to identifying those that were at a proper stage of conceptualization, had realistic expectations, and looked to be most suitable, in terms of investment of substantial time and energy, for further development. Of all the projects presented at the Institute by the participants, Dr. Ruth McClelland-Nugent's *Desperate Fishwives*, an early modern British social history game, stood out as the most likely to succeed. We secured NEH Level Two Start-up Grant funding and concentrated efforts with graduate student John Hodgson, involved in programming, and Grace Hagood, former participant and USC doctoral student in Composition and Rhetoric, involved in scripting. Dr. McClelland-Nugent has provided the discipline scholarship in history, while we have coordinated the efforts.

*Desperate Fishwives* is a social history game (see Figure 1) designed for one to eight players at the college and advanced high school levels. It intends to introduce students to the kinds of social and

cultural practices that would have been “in play” in a 17th century British village. The game’s aesthetics rely on two-dimensional woodcut images, appropriate to the period, and intended to make familiar to students the visual codes that correspond to the game’s historical setting. The point of the game is for students to learn about early modern British living by enacting historically-informed social interactions and cultural rituals through gameplay. By means of individual and collective game play, students attempt to resolve one of a variety of social ills common to the time (e.g., spouting heresy, abusing apprentices, premarital pregnancy); this ill threatens the communal life of the village--and is best addressed by the village citizens to forestall what is referred to as “the Big Bad”—the formal intervention of either church or state. Resolving the problem of the social ill is accomplished by successful accumulation of resources (goods, information, reputation) across a collective of characters, and the successful completion of a pertinent social ritual (e.g., gossip, economic non-cooperation, shaming). At the conclusion of gameplay, students are presented with a chronology of their individual and collective gameplay so they might translate their gamic experiences into a prose account of “what happened” and thereby learn about the nature and complexities of historiography.

By exploring the dynamics of order and disorder in early modern England, students begin to understand how community dynamics are key to understanding in a very concrete way the social history of the early modern world (c. 1500-1750). Most English people lived in small communities, with the parish as the most important administrative unit. Their world had no police force, no standing army, and a judicial system that visited these far-flung villages only occasionally. In spite of the absence of authority, most communities prospered, paid taxes, and remained obedient to the crown. Order was maintained largely from the bottom up, not top down, via daily social interactions and interdependent dynamics that some historians have dubbed “neighborliness.” By participating in historically grounded social exchanges and rituals, students become better equipped to make claims about how their present pertains (or not) to the lived past.

### **Realization: “Critical Interactive” and not “Serious Game”**

We are currently finishing work on *Desperate Fishwives* and will have a functioning prototype in April 2012. As we have pursued DF—especially in the context of team-teaching a “games” course (Fall 2011) that brought together undergraduate and graduate humanists and computer scientists—we have come to realize certain limitations attributable to the term “serious games,” and more broadly, “gaming.” Quite simply, the word “game” and its derivatives—of habit—connote fun. But the projects we are interested in pursuing do not promise fun. While *Desperate Fishwives* and the projects we saw at the HGI take a more game-like approach to their content, they do not intend to be fun *per se*. Their use of gamic elements functions to impart educational content but in ways that are not rote skill-building activities disguised as games. As such, they push beyond more conventional modes of scholarly endeavor that tend to position their audiences as passive recipients of knowledge. We have begun to use the term “critical interactive” to emphasize this shift.

Informed by Mary Flanagan’s scholarship on “critical play” (2009) and Ian Bogost’s work on “procedural rhetoric” (2007), the term “critical interactive” proposes that there is another viable way to impart knowledge, build awareness, and provoke thinking and raise questions. Specifically, we imagine a mode of scholarship that invites people to imagine themselves to be active participants in conversation with the materials of intellectual inquiry. What computers and their mobile and desktop interfaces offer is the possibility for more dynamic access to knowledge. In this regard, critical interactives are an alternative to the scholarly monograph, which continues to be the privileged vehicle for the dissemination of knowledge in the humanities. Certainly, critical interactives do not dispense with critical inquiry into socially-, politically-, and/or philosophically-charged questions. But unlike traditional scholarly practice, they take advantage of ludic methods in order to invite an audience to engage critical—by which we mean, theoretically-informed and ethically-oriented--questions and/or problems that affect a community of individuals.

In this regard, we contrast our notion of critical interactive with more familiar consumer- and tourist-oriented applications and programs, such as museum and historical site tours, which generally proceed in linear fashion. While they may have the display afforded to mobile devices and screens, they tend to be restricted to a narrative and often didactic treatment of content. Our notion of critical interactives includes the ludic devices of dialogue trees and multiple paths by means of which participants are afforded the capacity to move through content in diverse ways. Much of the attraction of games is the experience by the participants of a variety of options that can be selected and the uncertainty of the outcomes, because the outcomes depend on the nature and the quality of the

"play." These features are essential to our conception of critical interactive. The potential for surprise or discovery that play engenders is what we endeavor to achieve. But our goal, in the case of DF, for example, is to facilitate discussions about the contingency of historical accounts. By inviting participants to engage a variety of historically-informed "play" scenarios, we propose to encourage more complex understandings of history as a construction; that is, that any history is written by someone according to a certain perspective, and that differing interpretations of an event are possible.

We acknowledge that *Desperate Fishwives* offers a first but limited example of the kinds of thinking that "critical interactives" might invite. First, we are very aware that to date much of what we have endeavored to accomplish with DF is hypothetical (because it has not been demonstrated in final form). Moreover, the "game" suffers from an overly rigid or deterministic "play" structure. Players have few play options, which constricts the kinds of experience that might generate diverse "histories." Likewise, the "win" state or final outcome, i.e., to accomplish a social ritual that keeps the State/Church at bay, is heavily prescribed. Nevertheless, we maintain that *Desperate Fishwives* holds promise: the fact that students are invited to be in conversation about their approach to resolving a specified "Big Bad" and, subsequently, that they have an opportunity to provide a written account of how that feat was accomplished based on a chronological list of events that is generated at the conclusion of a round of play. We hope they might discover that their accounts of their "game play" experience will resonate with but also counter (or provide a contrast to) the kinds of histories they are accustomed to studying.

### **A First Generation Critical Interactive: *Ghosts of South Carolina College***

Our thinking about "critical interactives" has evolved substantially as *Desperate Fishwives* has been developed and as we have examined the developing game. Responding to our understanding of the limitations of DF, we have begun work on a second prototype, one that better demonstrates the features and functionality of what we would consider to constitute a critical interactive. An Augmented Reality (AR) application called *Ghosts of South Carolina College* (GSCC), this second project endeavors to bring into view—literally, on mobile micro screens (e.g., iPhones and iPads)—the largely unknown history of slavery that made materially possible the physical site of what is now the University of South Carolina. Its deployment of ludic or gamic mechanics and architectures aims to generate awareness and questioning about what might otherwise seem status quo. It features the University of South Carolina's historic Horseshoe, which is and has been "central" to campus and to campus happenings. As a site, it is rarely (if at all) questioned by students or visitors who traverse its grounds. We can change this perception by inviting those who are on-site to "see" the site through a different "lens"—one that provokes and reminds visitors, students, scholars, administrators, laborers, and members of the surrounding community of the institution's complex history. We take as our point of departure the robust scholarly website, "Slavery at South Carolina College, 1801-1865" (Weyeneth, et. al., 2011), which is the product of public history investigations by faculty and graduate students of USC.

At present we envision three distinct "layers" that address overlapping and complementary points of departure for thinking about and engaging with the historic Horseshoe: a) the historic campus Wall that still today delineates the boundaries of the original South Carolina College; b) the "disappeared" slave quarters and kitchen buildings that historians can document and map but that modern visitors to the Horseshoe can no longer see; and c) the story of slaves and slavery at South Carolina College that links the extant and missing buildings into a comprehensible "landscape of slavery." Those traversing the site with Wi-Fi- and GPS-enabled screen technologies, such as the iPhone, will be invited to download the AR application. Likewise, we foresee the University's Visitor's Center, the University's freshman orientation course (UNIV 101), and [public] history courses directing people to the application. Those who elect to participate will be able to activate one or more of the three layers.

As currently planned, the activation of any one of the application's layers will mobilize AR and WiFi functionality as well as location awareness. Activating layer "a" will draw attention to the character and legacy of the USC Wall. As one explores the historic Wall in real-time, she will have access to an accruing combination of narratives that suggest the ways in which places acquire identities. The narrative will evolve in relation to a participant's real-time physical exploration of the Wall as it is imagined to function variously as perimeter, boundary, threshold, barrier, etc. The point is to encourage participants to consider how binaries such as inside-outside and inclusion-exclusion have functioned to define the institution of the University as a site for the organization and management of

people. Layer “b” will represent on mobile micro screen virtual reconstructions of, for example, once extant antebellum outbuildings in the context of the many still-standing buildings (see Figure 2). One of the intentions of this architectural “ghosting” is to draw attention to the ways that a history of place requires an “eye” for how institutional landscapes take shape in the context of politically-motivated (matters of funding, leadership, etc.) physical transformation, and that such transformation always results in material loss of some sort. Finally, layer “c” focuses on people, i.e., on fictionalized versions of interactions between slaves and students in the antebellum period at South Carolina College. As one walks the Horseshoe ground, she will have opportunities to interact with “ghosts”—historically-based, creatively-imagined personages—whose histories have largely been forgotten or erased (see Figure 3). Thus, layer “c” makes visible how slaves and racial slavery underpin the growth and expansion of an institution such as the University of South Carolina.

Unlike DF, which deploys a gamic architecture to focus student-players’ attention on modes of sociality particular to a 17th century British village, GSCC challenges its participants to engage with a history that has made possible the current institution that is the University of South Carolina. As a critical interactive, it charges its participants to acknowledge their relation to this history and embrace a responsibility to a legacy that has been obfuscated—and continues to be so. In other words, *Ghosts of South Carolina College* aims to intervene in how people approach, “see,” and experience the physical grounds of the Horseshoe as a site of historical erasure. It does so in order to counter what has been a persistent and unacceptable social blindness.

The authors present *Desperate Fishwives* and *Ghosts of South Carolina College* as representative of two moments in a trajectory of thought about “serious games.” They provide evidence of a process that produced the concept of “critical interactive.” In positing this concept, we do not intend to dismiss the potential work of serious games. Rather, we want to consider how interactivity as made possible by ludic methods might facilitate an appreciation for potentially controversial material. In comparing and contrasting the two projects, we hope to generate an examination and discussion of the shifts in their thinking about how ludic methods might provoke critical engagement with sensitive content.

## Conclusion

The authors propose the neologism “critical interactives” as an alternative to the [more familiar] term “serious games.” Our purpose is to call attention to the complexities involved in gamifying sensitive (even controversial) content. We offer two projects, both currently under development, that in tandem offer an opportunity to think about the critical, in this case socio-theoretical, work that ludic methods might accomplish. Drawing on a variety of site-specific projects—the NEH-funded Humanities Gaming Institute, the resulting *Desperate Fishwives* prototype (also NEH-funded), the collaboratively taught Gaming the Humanities courses (fall 2011), and the recently imagined *Ghosts of South Carolina College* augmented reality application—we intend to initiate a discussion about how gamic logics might invite critical engagement in, for example, socio-cultural or socio-cultural phenomena.

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## Figures



Figure 1: Desperate Fishwives interface

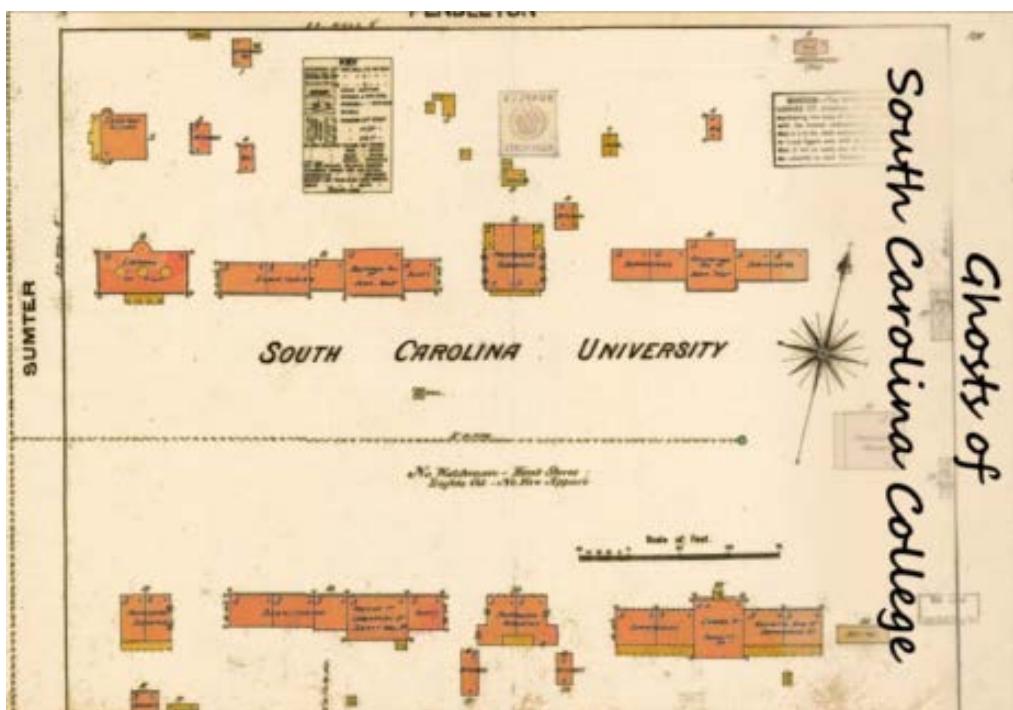


Figure 2: Buildings/Outbuildings of South Carolina College



Figure 3: An AR Layering of the Ghosts of South Carolina College

# **Designed Controversies: Creating teachable moments about research ethics through games**

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**Abstract:** In this “working example” paper, we argue that designers and researchers need to reflect more on the way controversy and transgression can create teachable moments and memorable experiences in learning games. In doing so, we present a “worked example” (Gee, 2009) of our design choices related to controversial and transgressive play in a game series about research ethics, called Gaming Against Plagiarism (GAP). Employing data from usability trials, we argue that building controversy into learning games can force students to think critically and deeply about ethical issues.

## **Introduction**

The experiential learning paradigm embodied in many games makes them more powerful learning tools than skill-and-drill tutorials because it offers learners the opportunity to make meaningful decisions and enact compelling experiences. The experiences found in games are compelling in part because games offer players psychosocial moratoria (Gee, 2003)—safe spaces where they can experiment with a simulated system that has lessened real-world consequences. But few learning games take advantage of this feature commonly found in commercial games by providing players with opportunities for transgressive play. Fewer still mobilize the “safe space” of games to force players to confront “designed controversies” that make them think critically about a given issue.

In this paper, we argue that designers and researchers need to reflect more on the way controversy and transgression can create teachable moments and memorable experiences in learning games. In doing so, we present a “worked example” (Gee, 2009) of our design choices related to controversial and transgressive play in a game series about research ethics, called the *Gaming Against Plagiarism* (GAP) project. Furthermore, we present data from usability trials to ask whether building controversy into learning games can create a space for students to think critically and deeply about ethical issues.

## **Background**

As the saying goes “good research is ethical research.” But what is the definition of ethical research? Based on a study conducted at the University of Florida, results show that Science, Technology, Engineering and Mathematics (STEM) graduate students have varying degrees of understanding the basics of what makes good, ethical research, especially with regard to falsification of data, fabrication of data, and plagiarism (FFP) (Leonard et al., 2010). The push to make American STEM education initiatives more successful lead to a search for new curricula, pedagogical techniques and learning technologies that can aid in this endeavor.

As a learning technology with the potential to engage students, computer games stand out at the forefront of this push. (Gee, 2003; Shaffer et al., 2005). This project, supported by a National Science Foundation Ethics Education in Science and Engineering grant, employs a series of interactive, digital “mini-games” to educate and inform graduate STEM students about the dangers of research misconduct and cheating. It seeks to not only teach students the facts of what constitutes research misconduct, but to also educate them about the values associated with ethical scientific research conduct and procedures.

## **Theoretical Framework**

The past decade has seen a tremendous proliferation of research on learning games and virtual worlds. From this scholarship, a number of worked examples provide researchers with general lessons about how to create successful social learning environments around games (Squire et al.,

2008; Steinkuehler & King, 2009). Seeking a better understanding of the social learning and literacy practices embodied in gaming, basic research investigated commercial game-based learning spaces (Steinkuehler, 2006) and identified characteristics of gaming spaces that make them productive learning spaces. This basic research has informed the design research projects that seek to create intentional game-based learning spaces. However, one finding of basic research that has not been translated into design practice is the relationship that controversy and “transgressive play” have to learning.

For the purposes of this worked example, we call transgressive play that which goes against the grain of expected social conduct—an act or series of acts that would be considered taboo, unethical, immoral, or otherwise inappropriate in the real world. We 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. Other studies of game-based learning communities have found that the desire to playfully transgress often drives the pleasure and engagement derived from a game. Squire (2007) found that transgressive play often heightened players’ engagement with *CivWorld*, a history-focused game-based learning environment centered on the Civilization game series. This transgressive play drove students to explore and experiment with the game’s model of world history, and propelled them further into an identity transformation from a user of popular media into designers of world history simulations (DeVane et al., 2010).

Other research has drawn similar conclusions. Consalvo (2009) found that “cheating”—the use or development of walkthroughs, hacks, tips, etc.—drives players acquisition of “gaming capital” in gamer communities. Kafai & Fields (2009), drawing on data from cheat sites for the *Whyville* virtual world, argued that cheat sites help players build their competencies as designers. In a study of youth who played *Grand Theft Auto: San Andreas*, DeVane & Squire (2008) found that the opportunities for play-based transgression, ranging from silly to violent, were key motivators for players. Play that pushes back against the defined structures of a game, or against defined social norms, can heighten player engagement.

Some evidence suggests that ethically-ambiguous situations, and transgressive role-play, can help players build metacognitive models of a given moral context. Simkins and Steinkuehler (2008), for example, contend that controversial role-playing scenarios foster critical and experiential engagement with ethical systems and values. This research indicates that transgressive play can heighten player engagement, and promote learning through experimentation, critical thinking and design. In this spirit, the *Gaming Against Plagiarism* project seeks to create “designed controversies” and opportunities for transgressive play in order to foster engagement and critical ethical thinking.

## Methodology

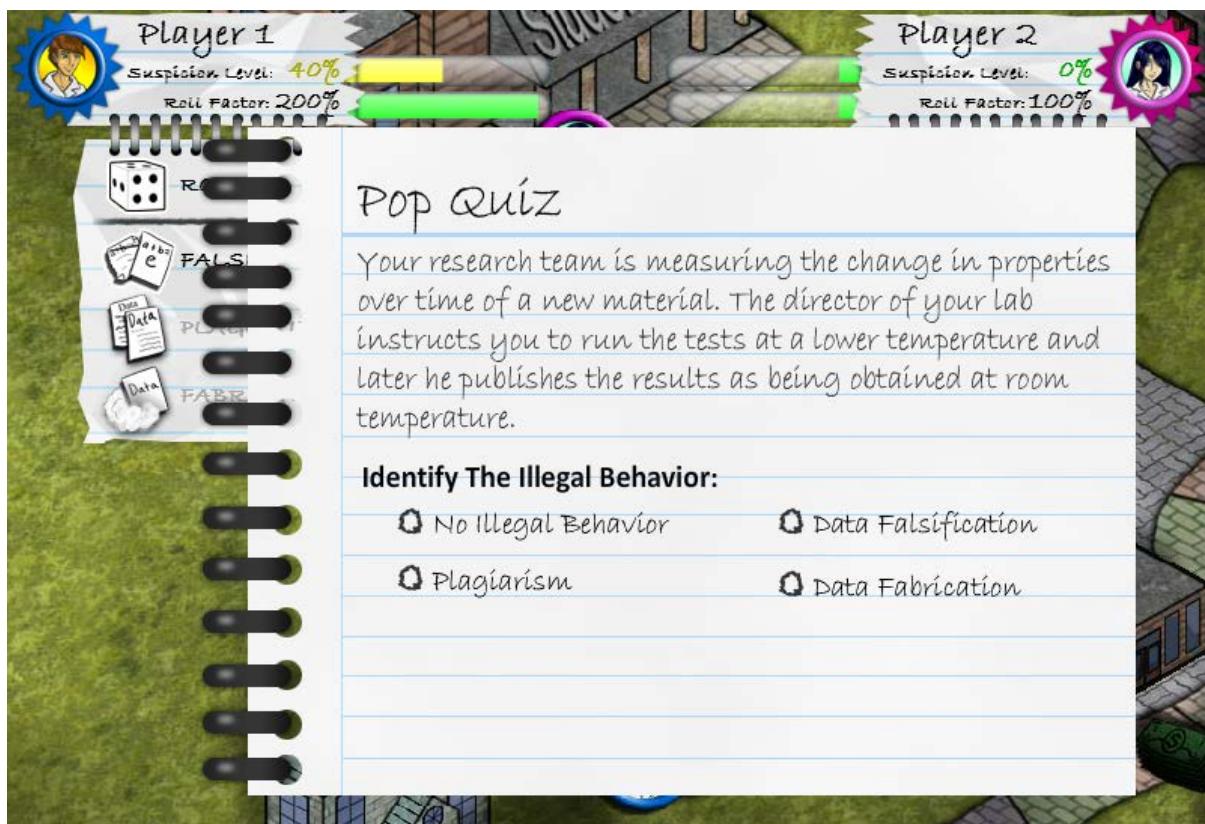
Methodologically, this paper draws from the project’s in-progress usability testing and evaluation. Other in-progress evaluative research not reported in this paper focuses on assessing learning gains. The game design and development team employed the iterative framework of *agile development* for our development processes, which emphasizes incremental and iterative organizational solutions to deal with that uncertainty (Rajlich, 2006). Using a design document as a flexible guidepost, the agile development process allows for easier adjustment of the virtual game environment as the content and design teams refine their understanding of how to fit pedagogy and playability together through rapid prototyping and usability testing.

## Game design context

The data presented in this paper comes from usability tests of two game prototypes, the first and third mini-games of a three-game series. The design metaphor of these two games, titled *Cheats and Geeks* and *Murky Misconduct* respectively, were crafted to allow the player opportunities for transgressive play. Designed to appeal to casual game players by drawing on classic game design metaphors, the player inhabits two distinct roles in these games. In the first game, *Cheats and Geeks*, players inhabit the role of a desperate graduate student who competes with his colleagues in a race to garner funding for his graduate career by publishing papers. As players sprint towards their goals across a “chutes-and-ladders” style board, they can plagiarize, falsify or fabricate their positions, all while trying to keep campus authorities off their trail and testing their own knowledge of research misconduct (see Figures 1 & 2). In short, the players of this game can build their basic knowledge of research ethics by strategically committing research misconduct in-game. The opportunity to learn by doing is also the opportunity to play transgressively.



**Figure 11: Cheating one's way to research funding**

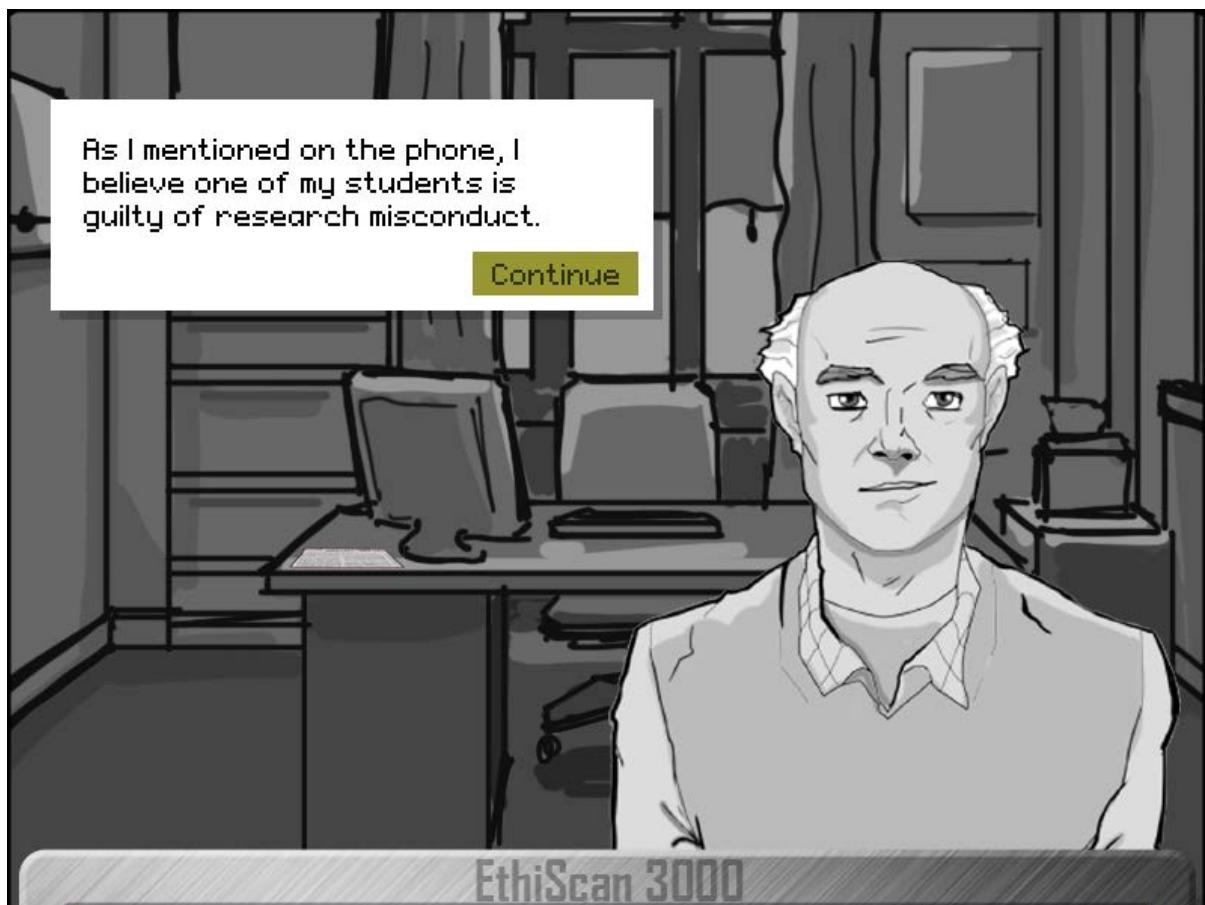


**Figure 12: Peer reviews panels inquire about research ethics**

The third game, *Murky Misconduct*, finds the university in near-chaos because research misconduct is rampant. After the first game, the player is drafted into the Research Ethics office as a detective, the fictional agency of the university dedicated to tracking down research misconduct. Now the player's character is out to find and convict the unethical researcher whose sinister work is threatening the university itself. In doing so, the player untangles a series of cases in which they have to analyze materials, make arguments, and provide supporting evidence (see Figure 3). The misconduct mastermind the player must confront, it turns out, is a distinguished professor who has been mistreating his graduate students (see Figure 4). Research misconduct, it turns out, is not only *done by* graduate students. It is also *done to* graduate students.



**Figure 13:** Argumentation & evidence interface



**Figure 14:** Confronting the serial cheater

### Usability testing & protocol analysis

As part of the iterative design process, usability testing forms the core mechanism for acquiring player feedback on virtual environment design and player experience. Our usability testing centered on interface design issues, content refinement and level of playability for each game prototype.

Depending on the game prototype's format and the feedback needed, the usability team conducted "think-aloud" protocols of game play. The overall test cycle lasts fifteen days (three work weeks) and consists of testing initiation, participant recruitment, protocol development, user testing sessions, and a usability report.

From these testing sessions we gathered and analyzed verbal reports from players using "think-aloud" protocol analysis (Ericsson & Simon, 1984; Jourdenais et al., 1995), and then used that data to inform and refine the game design and content development. Using the "think-aloud" method, we asked two groups of four users to verbally and continually report what they were thinking as each group played one of two games in the series. Consistent with standard protocol analysis methods, researchers gave each participant the same introduction to the usability testing procedure, and audio-video recorded their verbal report and game play. As Ericsson & Simon (1984) note, these recorded utterances and actions provide us with a glimpse players' knowledge schema and problem strategies.

## Results

The game's designed controversies provoked very different reactions amongst the usability testers, but usability test results suggest that it may be a means to create "teachable moments" about research ethics issues. In usability tests for Game 1, *Cheats & Geeks*, players decided whether or not to cheat to advance their fictional research career. Likewise, players of Game 3, *Murky Misconduct*, confronted a professor, who had falsely blamed one of his graduate students, with allegations of research misconduct. These designed controversies created openings for some testers to engage with and discuss the game's fictional situations and material.

### Discovering models of cheating

The portrait that emerges from the usability data gathered to date suggests the issues surrounding ethics and learning in play are complex. In *Cheats and Geeks*, the first game, most players availed themselves of the ability to cheat in-game, but it appears these choices had little to do with their ethical stances. Instead, most players framed their choices in terms of experimentation with the game's underlying model of the rewards of cheating and the risks of getting caught. Two of four usability players cheated repeatedly throughout their game play, and complained that the games' chance to catch cheating was high. To the detriment of their chances to win, these two players frequently attempted to cheat despite frequently being "caught" by the game and penalized. One remarked that there was a high chance in-game cheating would be caught, which probably did not reflect the real-world risk. These players were focused on investigating the game's model of the risks posed by cheating.

Cheating, however, was not universal amongst the play testers of the first game. Two other players cheated once and twice in the game respectively. Only in the case of one player did this seem to be tied to an ethical stance. This player cheated once, was caught, and then cheated no more. She said that "the option to cheat was not an option" for her, and that she had only cheated the one time to see what would happen. The other player cheated twice, got caught both times, and remarked that there "seems to be a higher chance of winning if you don't cheat." For one player, cheating in-game seemed to be a moral issue, while the other player thought not cheating provided a pragmatic advantage in-game.

### Accusing the professor

In order to complete the third game, *Murky Misconduct*, players had to track down a serial cheater who was tarnishing the university's reputation with his research misconduct. This cheater turned out to be a distinguished professor at the university, whom players had to confront with evidence of his misdeeds. The four play testers of this game had differing views of the controversy designed into the game. Upon realizing, after 25 and 33 minutes of game play respectively, that the professor was the wrong-doer, two play testers reacted positively. One remarked that he liked that the professor falsely accused the student when the professor was actually to blame. The other let out a loud and extended laugh at the moment of discovery, and proudly exclaimed, "I like this—[I'm] going straight to the top!"

Two other play testers, however, reacted differently. One expressed discomfort accusing a professor for research misconduct and wanted more sympathy for the character. The player indicated that many people "have issues with not knowing the basic definitions [of research misconduct]" and discussed how he would try to help Professor Gibbons rather than accuse him. Another, in an after-game

reflection, seemed dismayed that a professor might be involved in wrongly accusing a subordinate student.

## Conclusion

We here make an argument that creators of learning games, especially designers of games for ethics education, need to confront issues of transgression and controversy in game design. Thus far design research has mostly ignored them, which is a disservice to the experiential affordance of games. We believe, as do Simkins & Steinkuehler (2008), that simulated dilemmas provide players with a space to engage critically with ethical issues.

But at the same time these design choices provoked strong reactions from institutional stakeholders, who sometimes worried that graduate students would learn to cheat from the game. For example, one stakeholder, a researcher interested in ethics education, worried that experimenting with research misconduct inside the game might lead students to try to cheat outside the game. Another stakeholder was concerned with the constrained choices players faced in these controversial game-based situations. These concerns are founded in a belief that a game should produce outcomes and not starting points for discussions.

For many play testers, the designed controversies appeared to engage them and stimulate their interest in exploring the games' model of research ethics. Others, conversely, seemed offended that there were even options to cheat and commit research misconduct. We hypothesize that these points of excitement, or distress, open up "teachable moments" for discussion of the complex ethical issues that face graduate researchers.

But questions remain about how we understand transgressive play relative to learning in games. For example: How does transgressive play enter into dialogue with the ethical and educational intentions of learning game designers? Does transgressive play change the way that players construct knowledgeable identities in game play? Are some players intimidated or disgusted by design paths that incorporate transgressive acts? These and other questions related to controversy, transgression and ethics remain open in the learning games literature. We hope this "working example" can spark more discussion on, and investigation into, these important issues.

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## Worked Example: *Cosmos*

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**Abstract:** We propose, in this session, to illuminate the development process for a Massively Multiplayer Online Game for science and mathematics learning, with the working title, *Cosmos*. Because the size of the project encompasses a number of complex design and research questions, we would like to invite the GLS community to work through our thinking with us—to challenge us and contribute to our thinking. Which details get worked will be decided in part with the members of the community that attend the session, but we will be prepared to discuss everything from general pedagogical frameworks for science learning to specific quest mechanics, and everything in between.

### Introduction

*Cosmos* is a Massively Multiplayer Online Role-Playing Game (MMORPG) for science and mathematics learning, recently funded by the Bill and Melinda Gates Foundation. Development began in December, and a great deal of work has already been done to develop the world for its inhabitants and their activities. Using an experiential learning framework, players will complete embodied tasks and investigate problems big and small, both on their own and with one another. The curriculum for the first wave of development will focus on the Core Curriculum standards for geometry, statistics, and probability and the Next Generation framework for biology. Furthermore, the curriculum will connect players with an identity as a science learner and concepts of systems thinking through the Nature of Science.

*Cosmos* will be an excellent Worked Example session because the project will be at a prime moment to invite the Games, Learning, and Society community in to discuss the game's central design, narrative, learning, and technological conceits. Several potential examples are presented within this paper, but for a project this large, only a few aspects will be unpacked in the session. Those aspects will be chosen based on the aspects the investigators deem most in need of discussion at that phase of the project as well as the expertise and interests of the session attendees.

### Investigating the World of [*Cosmos*]

*Cosmos* aligns the needs of a learning environment with the affordances of MMOGs. The unique affordances of massively multiplayer environments have been shown to foster *scientific thinking*, *scientific identity* and *inquiry skills*. While a true educational MMOG has yet to be created, several initiatives have created Multi-User Virtual Environments (shared virtual worlds, with tasks, but lacking some of the individual structure and all of the collaborative components) such as *Quest Atlantis*, *Whyville*, and *River City*, which suggest the potential of this format for learning (Kafai, Quintero & Feldon, 2010; Barab, 2007; Ketelhut 2007; Ketelhut et al. 2007; Nelson et al. 2007). Due to being massive and persistent, the open ended game play of an MMOG encourages a sustained investment in "*systems based reasoning*, *model-based reasoning*, [and] *evaluative epistemology in which knowledge is treated as an open-ended process of evaluation and argument*" (Steinkuehler & Duncan, 2008). Moreover, this reasoning is often done collaboratively (both synchronously and asynchronously) with peers. *Cosmos* takes a unique approach in the way it deeply integrates STEM practices as core game mechanics in a collaborative, mentored space that allows for innovative assessment and just-in-time scaffolding. This means not just the investigative aspects of STEM, but also the emerging technology and engineering literacy standards and 21st century skills like collaboration, all key to the practice of science today.

*Cosmos* is set in a robust, fantastic, and alluring virtual world with a great number of natural properties and phenomena, modeled on real-world scientific principles. Students will need to investigate these phenomena in order to solve the game's puzzles and to advance in the game. Players' central task in the game will be to manipulate, test, explore, predict, question, observe, and make sense of *Cosmos'* virtual world. In order to make this compelling, the world will be a multi-layered model consisting of multiple complex systems and simulations. Some content will be high fidelity models of systems from our world, and some will be more fantastic systems (still obeying known scientific laws) with their own unique features that players must discover. The processes of

investigation will resemble those of contemporary practitioners however, and are still modeled on established scientific laws and principles. For instance, the world models ecosystems that could be tracked and influenced by biologist characters. Players will not simply memorize facts, but they will use scientific methods of investigation and inquiry to penetrate these simulated systems. While the individual animals and plants may be fictional, they will be based on real principles of ecology.



**Figure 1: A hypothetical street scene from *Cosmos*.**

Because the various tasks in *Cosmos* will require the use of *real* learned skills, we can assess how the player is doing in terms of their knowledge and skill development in each content area. This is a mastery-focused pedagogy, requiring players to thoroughly master a topic before moving on, instead of moving on when the pace of the class demands, regardless of the students' understandings. All of this information can be summarized and accessed by the teacher to provide data on student performance on the required topics. Through this data, the teacher may provide additional in-game (directly themselves or via other students in the class who have mastered the content) or out-of-game assistance for those students who are struggling, thus creating a tightly linked feedback system. Teachers may optionally assign "grand" quests in topic areas, which act as a summative assessment for the unit, in which students must demonstrate their mastery of the topic. Take the following sample narrative, for example...

### Example (To Work)

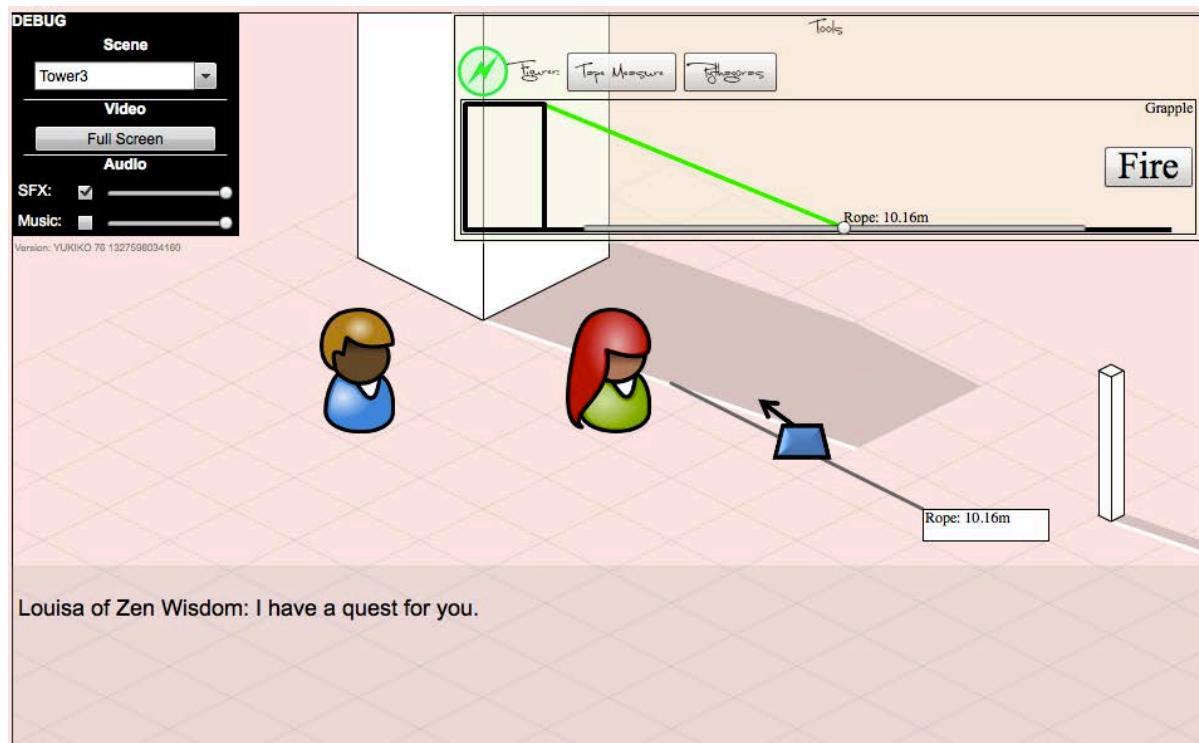
Cathy is a high school math teacher preparing to use *Cosmos* in her class this year. She goes to the *Cosmos* website to create her class and choose the quests (tasks) and talents (skills) for her class based on her curriculum. She answers a few questions about the grade, topics and textbook she uses, and *Cosmos* suggests the Architect talent tree. The talent tree is a sequencing of skills common to many MMOs. In this case, the sequence is the progression of math topics across the course. Students are required to master a topic before moving on to the next. Within this tree Cathy has the option of reprioritizing skills (placing them higher or lower within the tree) with some restrictions on topics that build upon each other, requiring one to come first.

When the students embark on the game, they will need to progress up the talent tree, building the necessary skills to advance to the next level and acquire more skills and explore new lands. Students

who do not perform well enough on quests in a particular skill area will not earn enough experience points (XP) to move on to the next talent, and instead will need to complete more quests in the areas in which they are building skills.

For example, consider the case of Susan, embarking on this sequence in Cathy's class. Susan's first assignment is to create a Figurer character. She winds up doing this on one of the library computers after school. As the adventure begins, a cinematic introduces her to the world of *Cosmos*, establishing the story of the world and the role of a new kind of adventurer in investigating and protecting the world. Her character awakens in a cave, where she performs some simple operations in order to prove her worth to the Figurer's Guild and gets used to the controls and abilities. After completing these initial trials, she encounters a large number of basic operations, and proceeds about the life of a beginning Figurer.

After reaching level 10, an hour and a half after starting, she is oriented to the basic workings of the world and her basic palate of abilities. At level 10, she is invited by one of the leaders in the community (her teacher, Cathy) to join the Architect specialization along with her classmates. The Architect path and its attendant quests, carefully chosen and organized by her teacher, will now provide a free-but-focused space in the world for her to adventure in. A typical adventure for an Architect might look something like the following: On her way to deliver a message to her non-player character mentor in the central city, she happens upon two brothers who are clearly fighting. They have an Architect symbol lit up over their heads to indicate that they have a quest solvable by Architects. Upon talking to the brothers, she discovers that they are arguing about how to divide up the farm they've inherited. Neither brother thinks the other is giving him a fair deal. The brothers indicate the irregular property line and ask for her opinion, since Figurers are well respected in the world of *Cosmos*. Having recently completed "squares" as a portion of her training, she uses her abilities to quickly create a small square and apply a grid of identical squares over the property to investigate the overall area of the property (the land is flat). After some tinkering with the length of the square's sides, she discovers that indeed the property can be measured in squares without any left overs, so she draws a property line for the brothers that gives them equal portions of land. Having satisfied the brothers, she receives experience and a small allotment of gold, in addition to a new usable ability called "area." This ability will allow her to even more quickly create grids of regular shapes for similar problems.



**Figure 2:** An early prototype of the Tower quest.

A week later, Susan struggles with another quest however. For this quest, she must scale a tower that sits in the middle of a clearing. The nearby shopkeeper will only sell her exact amounts of indestructible rope though, and she has had difficulty figuring out how much rope she needs. After trying to reach the window with her existing grappling hook and failing, one of the nearby non-player characters offers her a suggestion that she think of the height of the tower as a leg of a triangle, while another non-player character discusses properties of right triangles. She opens her "Triangles" palate to do some exploring, but unfortunately she's just not sure how to find the length of the other two legs. She persists for a while and gives up. She makes a note in her online logbook that triangles may be involved, and heads back into town to talk to friends. None of them have gotten to that quest though, so she logs off for the night.

Over the weekend, while watching her classmate's soccer game, she notices her shadow. She realizes that her height and the length of her shadow form two legs of a triangle! She borrows a friend's smartphone and opens the *Cosmos* mobile logbook application. She hastily jots down, "Shadow forms one leg of the triangle, but...how to get the hypotenuse?!"

Cathy meanwhile, looking at the summaries of the class's progress over the weekend, notices the flag next to Susan's name. The flag indicates that while Susan has typically had a high quest completion to time spent ratio, she has been stuck on one quest for some time. She is directed to Susan's logbook for this quest and sees that Susan has associated the quest with triangles and has a good theory about the tower's shadow, but has not yet completed the quest. Cathy sends an in-game "gift", an ancient text describing a related parable, in her guise as Morgana, the leader of the class's Figurer's Guild. The text was chosen from a list of options of supporting materials for that quest through the teacher interface in *Cosmos*. She also decides to add a personal message, "It looks like you're having struggles of epic PROPORTIONS."

The next time she logs in, Susan receives Morgana's gift and understands her message loud and clear. After looking around the clearing for a bit for something she can measure to create a proportionate triangle, she realizes that her avatar and its shadow create a proportionate triangle. After measuring herself and her shadow, she measures the tower's shadow and finds the answer to the tower's height in her proportions tool. Not long after, she is headed back into town to make a deal with that buttoned up shopkeeper.

The dashboard features a header with 'Welcome, Susan.' and links for Students, Unit Planning, Guide, Account Settings, and Logout. Below is a main area with tabs for 'Select All', 'Skip Ahead', 'Remove', and 'New Student'. A table lists students by name, username, progress, and current quest. A central column shows a student's status ('Stuck on Plague Hunter for 12 minutes'), a chat log, and detailed progress. A sidebar displays recent activity logs.

	Student Name	Username	Progress	Current Quest
Appleseed, John	Applesauce	<div style="width: 100%;">Full</div>	Plague Hunter	
Burbank, Luther	Shasta	<div style="width: 50%; background-color: #f0c0e0;">Partial</div>	Petal to the Metal	
Bumham, Leo	leoPlayer	<div style="width: 50%; background-color: #f0c0e0;">Partial</div>	Smell the Roses	
Douglas, David	SurferDude99	<div style="width: 100%;">Full</div>	Smell the Roses	
Dioscorides, Pedanius	Dio_Man	<div style="width: 50%; background-color: #f0c0e0;">Partial</div>	Learning the Ropes	
Huxley, Thomas	BulldogHux	<div style="width: 100%;">Full</div>	Plague Hunter	
Linnaeus, Carl	i_<3_wigs	<div style="width: 50%; background-color: #f0c0e0;">Partial</div>	Plague Hunter	
Smith, Judy	judyPlayer	<div style="width: 100%;">Full</div>	Plague Hunter	
Thomas, Jack	jackPlayer	<div style="width: 50%; background-color: #f0c0e0;">Partial</div>	Petal to the Metal	
Wilson, Lara	laraPlayer	<div style="width: 100%;">Full</div>	Plague Hunter	

**Status**  
Stuck on Plague Hunter for 12 minutes.  
- Needs to breed Yellow Flower  
- Needs to reach the North Gate.

**Chat Log**  
[01:23] judyPlayer: Hey, another pink flower!  
[01:21] i\_<3\_wigs: How do you get to the north gate?  
[01:18] Applesauce: Whoa... you guys need to see this.  
[01:18] Applesauce: North gate, here I come.

**Detailed Progress**  
Learning the Ropes  
Petal to the Metal  
Smell the Roses  
Plague Hunter

Figure 3: A mock up of the teacher tools.

While Susan and other students in the class have been working on *Cosmos*, Cathy has been getting summarized reports and indicators of difficulties through the *Cosmos* website. At the highest level, Cathy can see how far everyone has progressed within the talent tree, indicating areas of strength and weakness, and new areas they decided to pursue. She can go further for particular students (as she did with Susan) to examine quest summaries that indicate how and why students have failed on those quests. While the in-game “class trainers” may have pointed the students at some helpful resources for the quests along the way, she can further support this system by providing extra assistance either in-game or in person, or by assigning group quests with other classmates who might help a struggling student.

## Working the Example

The preceding example is, of course, filled with assumptions about the mechanics, systems, and ideas that an experiential learning MMOG should inherit from traditional MMOGs. It is an open question, for instance, as to whether an MMOG should inherit an experience point-derived leveling system for its feedback and character progression mechanisms. For our session, we will unpack the systems most relevant to our project at that moment and to the assembled audience, inviting the audience into our design decisions. Care will be taken to make distinctions about what might be correct for our experiential learning MMOG vs. another type of learning MMOG, and we will discuss the formal properties of commercial MMOGs as well. Some possible topics in addition to drilling into specific hypothetical questing mechanisms and prototypes include:

- *Sustainability*: A central conceit of MMOGs is that they persist, continuing to be developed and expanded well beyond the initial life of the originally shipped title. This poses new and difficult questions for a research project surrounding social issues like access and equity, business concerns such as the transition from university property to some managing body, and research/design questions like whether to implement different versions of the game on different shards, even though it may produce unbalanced gameplay or confusion in the player community.
- *User feedback from very early user testing*: Early testing of the game will have occurred and still be underway. This will dig in not only to how players responded to various prototypes, but

what we will have learned about our player base and how our cultural model is adapting to the input of a nascent player community.

- *Considering disciplinarity, epistemology and class-based RPGs:* In this thread, we might consider our model in which players are playing through the lenses of mathematics and biology and how that relates to the collaborative work that emerges in science as it is practiced by professionals. We will be prepared to talk about mechanics that allow an entire shard to progress through scientific revolutions together based on their collective discoveries. In essence, these shards would be able to progress through a *Civilization IV*-style Tech Tree, but by the actions and decisions of all, not just a single player.

## Conclusion

The timing of the Games, Learning, and Society conference would be a perfect spot in the development of this very large and complex project to invite in our colleagues in the community for a discussion about its development and its core principles. Few places other than GLS would provide the right types of criticism and insight into such a big project. In turn, we hope to use our project as a means to discuss current research in the field and the development of large, complex projects that may have a life beyond research.

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# Game Design in a Traditional High School: A Worked Example

Danielle Herro, Oconomowoc Area Schools

**Abstract:** This presentation outlines the work-in-progress developing, implementing, and revising a game design curriculum offered to high school students as an in-school elective. Joining “digital media and learning” and “educational technology” pedagogies, the curriculum bridges out-of school interests, culture and social experiences with necessary, yet motivating, in-school competencies and practices. *Elements of Game Design* was created by an Instructional Technology Administrator, Technical Education and Visual Arts teachers in 2010, and implemented 9 times during the 2011-12 school year. The “Worked Example” (Barab, Dodge & Gee, n.d.) offers a model to discuss conditions necessary to garner support and success implementing an in-school gaming curricula including: planning, infrastructure, culture, policy, resource allocation, curricula writing, teacher expertise, and student voice. This worked example provides a media-rich overview of the process involved when offering an in-school gaming curriculum, and invites conversation around the curriculum to discuss efficacy, challenges, overcoming barriers, and next steps.

## Introduction

Game play and game design in the context of traditional classrooms is fraught with challenges making them an uncertain enterprise (Klopfer, Osterweil, Salen, 2009). Curriculum requirements, negative attitudes, logistics, training and support, evidence of effectiveness, inappropriate use, and stringent assessment requirements present enormous barriers to adoption (Klopfer, Osterweil & Salen, p. 18). Schools, notoriously slow to transform themselves, face additional obstacles when moving from basic literacies to applied, multimodal media-related skills unique to the 21st century (Collins & Halverson, 2009). Infrastructure and technical support often make in-school media-rich environments difficult to access. *The Digital Promise: Transforming Learning with Innovative Uses of Technology* (US Department of Education, 2010) proposes infrastructure, 24/7 mobile learning, digital media and games, and teacher training are worthy of funding, as leverage points the U.S. Government intends to capitalize on. As these issues are likely addressed, the influence of games and gaming principles towards high-quality learning may gain enormous traction. Enlisting, and better understanding, conditions that permit successful in-school gaming allows for appropriate curricula and project design. This presentation serves as a “contextual instance” to scaffold peer discussion eliciting “verification or refutation” for this type of game design curriculum in-school (Barab, Akran, & Ingram-Goble, Worked Example website, 2012).

## Review of the Literature Supporting Games for Learning

Gee and many other learning scientists provide powerful arguments to bring games or the principles of good games into classrooms (Gee 2003, 2004, 2005, 2007; Klopfer, 2004; Squire, 2005, 2006; Jenkins & Squire, 2004; Steinkuehler & King, 2009). Game-making offers a window into rich, meaning-making that affords systems thinking, complex problem solving, storytelling, creativity, and a host of digital and visual literacies (Gee, 2007; Klopfer, Osterweil & Salen, 2009; Salen 2007; Steinkuehler, 2010). The National Education Technology Plan (US Department of Education, 2010) points to embedded technologies in games, simulations, virtual worlds, and collaborative environments as promising learning and measurement tools due to their capacity to engage, provide immediate feedback, and offer sophisticated and complex assessments (US Department of Education, p. 15). Students play, and recognize games as learning opportunities and suggest games fit into their vision for 21st Century learning which includes: social-based learning, un-tethered learning and digitally-rich learning (Project Tomorrow, 2010). They value the use of games for learning believing they are engaging, make difficult concepts more understandable, and generally offer increased learning about particular subjects (Project Tomorrow, p. 20)

Gee aptly sums up the potential in offering game design opportunities stating, “Good game designers are practical theoreticians of learning, since what makes games deep is that players are exercising their learning muscles, though often without knowing it and without having to pay overt attention to the matter” (Gee, 2005, p.5) When referring to using game design principles for learning *in school*, he suggests the greatest cost may involve changing minds about *how* learning is done (Gee, 2005).

### **Bringing Games into Traditional Schooling: Creating a Culture of Participation and Support**

Undoubtedly, support for innovative curricula within traditional schooling is built over many years and involves, at minimum, a true understanding of the ever-shifting notion of literacy (Leu, 2000). The importance of 21st Century skills and new media literacies to affect teaching and learning environments must move beyond rhetoric and static text in research papers to envisioning the potential of digital media and game-based learning environments. Bridging research and practice with digital media and learning involves the research community considering and grasping the realities of schooling, and the practitioner community feeling compelled and equipped to make changes because they have witnessed, read and discussed research around digital media and learning. In this case, transformational practices occurred after: (1) core groups of district administrators and teachers read and discussed books such as *Disrupting Class* (Christensen, Horn & Johnson, 2008), *Rethinking Education in the Age of Technology* (Collins & Halverson, 2009) and *What Video Games Have to Teach About Learning and Literacy* (Gee, 2007). Staff attended numerous presentations focused on digital media, games, and emerging technologies to transform education. *Confronting the Challenges of Participatory Culture: Media Education for the 21<sup>st</sup> Century* (Jenkins, Clinton, Purushotma, Robison, & Weigel, 2006), became a staple of many on-site graduate courses, discussions, and on-site presentations, (2) entities such as Tech Cabinet were formed to vet, plan, and implement innovative ideas by core stakeholders from curriculum, technical support, administrative, teaching, and library-media staff and (3) on-site graduate courses and professional development communities were enlisted to read, discuss, plan, integrate, and revise digital media and learning opportunities into curricular areas. The supportive culture to participate with media and new media literacies, and purposeful efforts to work through challenges, when presented, was instrumental in moving the gaming curricula forward.

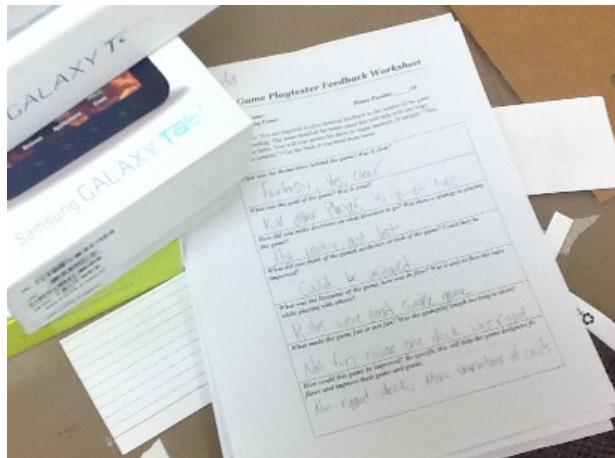
### **Planning and Implementation Process**

The process envisioning and implementing the curriculum in this example is summarized as: (1) consultation with UW-Madison's Games+Learning+Society (GLS) (2) surveying high school students to gauge interest, (3) research and course proposal review to gain Curriculum Coordinating Council approval, (4) writing and revising curriculum, (5) equipment and logistical considerations, and (6) curriculum revisions based on staff and students perceptions.

After a small team of district staff met with three graduate students from GLS to review practices from their summer game design camp for school-aged students, it was determined a mock syllabus and student survey would drive the decision to offer the course in the school district. One-third of the approximately 1,500 high school students viewed the syllabus and answered survey questions. More than 75% of students surveyed responded they might, or would definitely, enroll in a gaming course. A course proposal was drafted inclusive of research supporting game design as a medium for engaged learning; the Curriculum Coordinating Council unanimously approved the offering. The sections below detail the last three portions of the above-mentioned process.

### **An Overview of the Course: Writing the Curriculum**

Over the course of six months an Instructional Technology Administrator (ITA), Technical Education (TE) and Visual Arts (VA) teacher wrote the curriculum. The team was selected as the ITA had research-based experience in game play and design and the teaching staff expressed interest in teaching the new course. Research papers and books such as *MDA: A Formal Approach to Game Design and Game Research* (Hunicke, LeBlanc, & Zubek, 2004), *What video games have to teach us about learning and literacy* (Gee, 2003) and *Game Design for Teens* (Pardew, Nunamaker, & Pugh, 2004) provided an outline for the course, as did prior experience from the TE teacher, who was a gamer dabbling in game design during his middle school Technical Education courses. The VA teacher provided enormous expertise in activities meant to explore the aesthetics of gaming, and was adept at appropriate pacing, as well as formative and summative assessment criteria. Course documents were stored in Blackboard, and it was determined Google Apps would facilitate students' collaborative work and communication.



**Figure 1: Gamer Playtester Feedback Worksheet developed to peer-evaluate games.**

The course is geared to critically examine the history, usefulness, and elements of gaming with repeated opportunities to explore the mechanics, dynamics, and aesthetics of game design. Games are created and designed collaboratively; no formal texts are purchased, instead free or low-cost websites, videos, and game-based platforms such as *The GameCrafter*, *Kodu*, *Scratch*, *ARIS*, and *Daqri* comprise much of the project-based work. Gaming culture, experts, and organizations are threaded throughout the learning instances, and students collaboratively produce a short TED Talk taking a stance on an issue in the gaming industry. At the end of each term, students have experienced designing board, digital, and mobile games.



**Figure 2: Screenshot of student programming in Kodu.**

### **Technical Considerations, Logistics, and Cost**

While most of the above-mentioned platforms are low-cost or free, a dedicated lab with reallocated or additional staffing positions are undeniable budgetary concerns. Unblocking websites, bandwidth, and wireless infrastructure issues presented obstacles necessitating multiple meetings, testing, and follow-up with Technical Support staff. The districts' progressive stance towards unblocking educational sites did not pose policy issues. Materials to create games, commercially produced board games, and mobile devices for students without access totaled less than \$8,000; a fairly insignificant curricular cost considering the hundreds of students who will benefit in the coming years.

### **Game NOT over: Failures, Setbacks, and Successes**

The course begins by building background on the history of games and the video game design industry before moving through the process of reviewing, creating, and playtesting a board game. Introductory programming and logic are taught and practiced through various 2-D and 3-D platforms; *Scratch* was incorporated into the first semester course sections as unreliable Wi-Fi, and unresponsive technical support prohibited the use of *ARIS*. Ultimately, *ARIS* was more fully integrated

during the fourth quarter of the school year. Unsuccessful portions of the course, as evidenced by observation and student reviews, which included an HTML game and heavy-use of Blackboard, were removed or revised in favor of more time programming in Kodu and increased use of Google Apps. Requirements such as investigating aspects of gaming history, selecting workgroups, or the length of TED talks were tweaked or left open-ended to match course pacing and student preference. Surveys suggest students regard Kodu as highly engaging, uncomplicated, and effective in teaching basic principles of programming.

On a macro-level the course is already considered a success. Based on first-year questionnaires, a majority of students deem the design, projects, learning, and tools within the course exciting, relevant to their learning style, important in building skills for future preparation, and a gateway to careers (in their estimation) requiring collaboration, prototype testing, programming, game design, electronics, problem solving, engineering, graphic design, and logic.

### **The Teacher**

The instructor identifies himself as a gamer having tinkered with, played, and designed games since childhood. He clearly speaks the same “gaming language” as the students and understands the value and complexity involved in playing and designing games. When building background or providing exemplars, he draws on his gaming experiences. While no empirical data from this case suggests a “gamer” is best suited to teaching game design, in this example all observations indicate it assists in successful learning experience.

### **Student Voices**

In the fall of 2011, thirty-five (N=35) students enrolled in two sections of *Elements of Game Design* course elected to answer questions aimed at understanding their interests and perceptions of the course. Nine weeks into the first semester, 26 boys and 9 girls, responded to open-ended questions via a Google Form detailing their personal interests and hobbies, observations about the course, career goals, and suggestions for course revision. In the interest of being succinct, responses to three of the six questions posed are discussed.

When asked to describe themselves, and tell what they are most interested in (hobbies, interests, or future goals), students responses (n=number of responses) demonstrated interest in: playing video games (17), physical activities including snowboarding, sailing, dancing, football, track, cross-country, horse-back riding (21), and creative activities (13) such as building things, playing music, drawing, painting, photography and writing.

When asked, “What, if anything, do you think you learned?” responses were classified in the following categories: Game Process and Design (10), Technical Skills (9), Complexity of Games (9), Teamwork (6), History of Games (5), Time Management (2), Educational Value of Games (2), and Nothing (1).

Students overwhelmingly responded they felt the course was valuable, surprisingly challenging, and that the course could be improved by allowing them to choose their own partners for group projects. Three students suggested the technical level of the course was too difficult, and one student suggested we offer an after-school gaming club allowing additional gaming opportunities.

Understanding and listening to students’ views presents researchers and practitioners a window into designing meaningful game-based experiences, prospectively affecting future academic or career opportunities. If the course proves successful, this style of engaged learning and 21st century skill development will foster credibility with staff, other students, and community members.

### **Revisions**

It is unquestionably early to fully evaluate and revise this new curriculum; however the instructor has responded to student, technical, and methodological concerns by making minor changes. Group work and partnering has been rethought, an HTML game that students largely dismissed as trivial has been eliminated, and the development of mobile games have been scaled back until reliable Wi-Fi can be accessed. Next year sections of the course will be offered in a hybrid environment, and plans to include opportunities for student-designed Apps will be integrated in the curriculum.

## **Challenges**

While the visioning and approval process was relatively seamless due to the districts' culture supporting innovation, the actual logistics of implementation and future planning posed challenges to unblock and prepare the environment in time for the fall semester. Curriculum writing took six months of weekly meetings, work, check-in, follow-up, and revision by an invested group of teachers. Significant time and work in the preceding summer months was necessary to order equipment, prepare the lab, work with tech support, and finalize documents and projects. During the initial student implementation, weekly visits by the ITA were required to ensure technical issues that surfaced, and curricular questions, could be adequately addressed. Students electing to enroll in the course, at times, struggled with the complexity of the curriculum and intensive project work. Surprisingly, parents and community members were interested in, and supportive of the new course.

## **Conclusion: A Work in Progress, Suggestions, Next Steps**

One-hundred and seventy-four students, 41 girls and 133 boys, will take *Elements of Game Design* this year. Regular check-ins, quarterly meetings, staff and student critique, and game-based innovations influence the on-going revisions to make the course successful. Since project-based learning, ISTE NETS (International Society for Technology in Education, 2007) performance indicators, new media literacies (Jenkins et al., 2006) and 21st century skills (Partnership for 21<sup>st</sup> Century Skills, 2004) drive the course, achievement is measured in formative and summative assessments geared towards these standards. Common Core Standards and more defined measure of achievement have yet to be explicitly integrated in the coursework. Suggestions for others considering this endeavor include (1) encouraging teaching staff to read about, play, and discuss games before creating a game design curriculum, (2) including students in the visioning and/or curriculum writing process to ensure relevance and engagement, (3) working closely with instructors to provide the necessary technical and curriculum support, and (4) enlisting community support for mentoring and suggestions to help students design games around authentic local and global issues. An after-school gaming club focused on interest-based game and App design began in February of 2012, and the high school principal has requested the curriculum-writing team to propose a second offering of game design focused on higher-level design skills. *Elements of Game Design* is genuinely a "working example".

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# The Roles of Badges in the Computer Science Student Network

Ross Higashi, Sam Abramovich, Robin Shoop, and Christian Schunn

**Abstract:** The Computer Science Student Network (CS2N) is an online learning environment which uses badges—displayable student achievements—in several different capacities. CS2N Small and Medium badges are designed to provide motivation and document progress. These motivational effects persist in testing, consistent with Achievement Goal Theory. Knowledge badges document significant learning milestones and can be laid out along visual Pathways to concretely illustrate curricular flow for all stakeholders, including teachers, students, parents, employers, and even content developers. Teaching badges certify instructors as proficient in pedagogy relating to a Knowledge badge topic, and grant limited administrative rights to approve student progress. High Performance badges leverage learner performance data to identify outstanding students and instructors. Industry badges represent recognized industry certifications and constitute meaningful end goals to each curricular sequence. We believe this framework will support the long-term growth of CS2N, and can serve as a worked example for other badging systems.

## Introduction

Carnegie Mellon University's Computer Science Student Network (CS2N) is a cloud-based learning-system architecture where students, teachers, and hobbyists can earn badges and certifications as they play with, compete in, and learn about computer science and STEM-related activities.

The CS2N badge architecture was recognized as a winner in the 2012 Digital Media and Learning Competition (DML) to develop a high-quality badge system for both Lifelong Learning and Teacher Learning. The badge architecture serves multiple critical functions in CS2N by providing motivation, articulating curriculum, and serving as lasting indicators of learners' achievements.

This document represents a detailed description of the current state of CS2N's badge system design, including both those features which have been implemented, and those which are forthcoming. It includes a description of our badge types, theoretical underpinnings, preliminary research, detailed examples, and an overall description of how the CS2N architecture supports multiple opportunities to learn. We believe that this worked example can both provide a gateway for others to integrate learning applications directly into CS2N or develop similar badging systems for other learners.

## Badge Types

Table 1 shows the different types of badges in CS2N, differentiated by primary purpose and scope.

Small	Medium	Large – Recognition		
 <b>Small Badge Motivation</b>	 <b>Medium Badge Progress</b>	 <b>Knowledge Badge Content Proficiency</b>	 <b>Teaching Badge Pedagogy</b>	 <b>Industry Badge External Certification</b>

**Figure 1: Types of Badges in the CS2N System**



**Figure 2: A Sample Badge**

Simple design elements like the shape and imagery on the badge in Figure 2 above allow viewers to quickly get a sense for what a badge means, and estimate its relative weight as a qualification.

### **Badges as Motivator: Motivation Theory and Preliminary Research**

The CS2N architecture is built upon relevant learning science research as well as our own investigations. For example, recent literature suggests that badges may represent a new opportunity to combine motivational tools and assessment into a single construct (Antin & Churchill, 2011; Davidson, 2011). Consequently, when designing our badge architecture, one of the things we considered was how badge-based assessments might affect learner motivation.

Behaviorist learning science theories cite motivation to learn as originating extrinsically from the learner while constructivist learning science theories propose that the best motivation to learn emerges intrinsically within a learner (Greeno, Collins, & Resnick, 1996). However, the simple intrinsic-extrinsic dichotomy cannot fully explain the complexity within learner motivation regarding badges. Motivation and learning research has found it necessary to progress beyond simple intrinsic-extrinsic dichotomies to better explain learning outcomes, and a theory of badges should be rooted in that more modern theorizing. We choose to root our work in two well-researched and highly influential theories of motivation: Achievement Goal Theory and Expectancy Value Theory.

Achievement Goal Theory (AGT) identifies critical learning goals lying within a two-by-two matrix with Mastery and Performance on one axis and Approach and Avoidance on the other (Elliot, 1999; Elliot, Cury, Fryer, & Huguet, 2006). *Mastery approach goals* reflect a desire to master something based on self-interest in the subject or skill being learned. *Performance approach goals* reflect a desire to perform demonstrably better, while *performance avoidance goals* reflect the desire to avoid the appearance of underperforming. *Mastery avoidance goals*, reflecting a desire to preserve mastery in a

skill or subject, exist theoretically but have yet to be identified in most real-world contexts. AGT has proven to be a good predictor of academic performance in various academic subjects (Pajares, Britner, & Valiante, 2000).

When viewing badges through an AGT lens, several connections are possible. Students could be motivated to earn larger, more meaningful badges based on adoption of *mastery goals*. However, students could also be motivated to earn any type of badge, no matter how small, by a *performance approach goal* orientation to have more badges than their peers. But there is also some risk: While a mastery goal orientation leads to a positive learning outcome and a performance approach goal could lead to learning, students could also have a negative learning outcome by adopting a *performance avoidance goal* of earning just enough badges to avoid being identified as a low badge earner.

Another highly relevant theory to badges is Expectancy-Value Theory, which can be applied to unpacking the role badges play in performance and identity. At the top level, there are two parts: an *expectancy* (how likely will the learner be successful) and a *value* (is the outcome valued). These two are multiplied such that a learner must have both a reasonably high expectancy of success and some reason to value the outcome in order to engage (Wigfield & Eccles, 2000).

Badges could impact students by increasing expectancies for success, via positive performance feedback throughout learning. However, this is not guaranteed: if the badges are perceived as too easy to obtain, then students might attribute the badge success as indicating the character of the badges rather than their own skill development.

### Preliminary Motivation Results

Our own investigations have found that learners enjoy the introduction of badges into computer based learning applications. However, these preferences do not necessarily correlate with learning performance or with acquiring badges (Abramovich, Higashi, Hunkel, Schunn, & Shoop, 2011).

We are currently performing a quantitative analysis on learner performance for a trial run of a CS2N cognitive tutor. Our preliminary results indicate that our badging intervention reduced the levels of performance avoidance goals (that typically leads to students doing poorly). In addition, the number of badges earned by individual students correlated with drops in performance avoidance goals. In other words, our preliminary study indicated that the number of badges earned in an online learning tool predicted a decrease in negative learning goals.

We are continuing to pursue this line of research through future studies including an experimental manipulation of the presence of badges with monitored pilot groups in CS2N activities.

### Badges as Curriculum Map: Pathways and Badge Maps

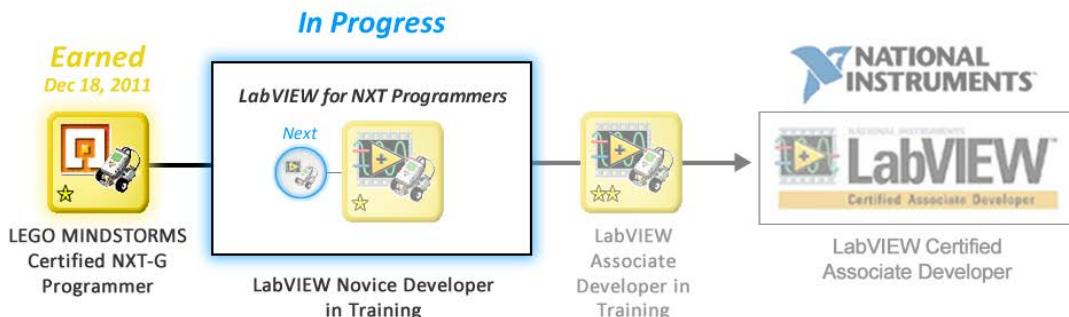
Badges are the key tool for organizing and understanding learning trajectories within CS2N. As students participate in CS2N activities, they progress down at least one Pathway, earning badges as they go. A CS2N Pathway is a curricular continuum from entry-level skills to industry certification or other formal recognition.

Each Pathway is developed in collaboration with the industry group or commercial partner who owns and controls the end-goal certification. A high-level Backward Design approach maps out important concepts leading up to the final goal, and Knowledge Badges are laid out to mark major content milestones. As it is the nature of Badges to be “earned”, these key points in the curriculum automatically become assessment sites.

Content modules from CS2N’s vetted pool of activities are chosen to deliver specific instruction aligned with these markers, and the Pathway is complete.

Pathways are illustrated using Badge Maps like the one in Figure 3. Each important learning milestone along the way is represented by its Knowledge Badge in the diagram. The current step is expanded to show Progress Badges as well. The student’s past and current progress are highlighted.

Badge maps provide clarity on the long-term value of student accomplishments, specify the “reward” outcome of a learning strand, illustrate a feasible progression toward it, and motivate students to continue pursuing it.



**Figure 3: A Badge Map Illustrating a Curricular Pathway**

### Badges as Evidence Trail: Programming Badge Example

To unpack the processes which govern and moderate badge issuance, consider the badge in Figure 4 below (as viewed from the CS2N website):



**LEGO MINDSTORMS Certified NXT-G Programmer**  
Master LEGO MINDSTORMS NXT-G programming concepts including Movement, Sensors, Program Flow, Logic, and Data Hubs.

Earned: 12/18/2011

Details ▾

**Requirements:**

- ✓ **(Bronze)** Complete the NXT-G Programming Mastery Exam with a final score of 90% or higher ([View exam](#))
- ✓ **(Gold)** Complete the NXT-G Build-a-Challenge Project and receive an instructor's approval ([View submission](#))

*Approved by D. Williams on behalf of LEGO Education North America*

**Pathways:** This badge is a step toward...

- 🔍 LEGO Education NXT-G Accomplished Programmer
- 🔍 National Instruments Certified LabVIEW Associate Developer

**Valid through:** This badge does not expire.

**Figure 4: An Earned Badge Detail View**

The badge's icon, name, date of issuance, and basic description appear at the top. A Details roll-down reveals additional information describing the badge's exact requirements, links to the Pathways in which it appears, and its expiration date if applicable.

#### Pathways

Clicking on a Pathway link in the Badge details shows the Badge Map for one of the Pathways that this Badge appears in (recall Figure 3 from earlier).

#### Earning Badges

CS2N encourages automated detectability and awarding of badges to enable self-paced learning whenever possible. The first Requirement listed for this badge is automated – completing a standard computer-administered online exam. Completing this exam satisfactorily earns the student a “bronze” level certification for this badge.

The second Requirement notes that a human instructor further approved credit for completing a specific challenge. Human instructors remain vital to effective content delivery in many settings, and CS2N has an entire top-level category of Teaching Badges dedicated to the development of their pedagogical capabilities. These same Teaching Badges grant instructors limited administrative rights within CS2N to approve a student's competency toward earning a content badge.

The Teaching Badge thus serves a dual purpose to promote the teacher's desirability as a candidate in a hiring decision: she will be both certified as capable, AND able to sign off on student progress for credit within the CS2N system. The system, meanwhile, benefits from added robustness against "gaming" by requiring human gatekeepers to sign off on key points in the process. A student who completes the additional requirements to procure this second, human-verified level of achievement is awarded a "gold" level certification.

Once a teacher earns her Teaching certification, she is able to approve badges "on behalf of" affiliate organizations which have authorized her to do so. This affiliation with a well-known issuing organization or designated PD provider strengthens the badge's claim to legitimacy, and provides promotional incentive for the organization in the process.

### **Badges as Assessment**

Traditionally, assessment of learning has been represented by the grades assigned in traditional schooling or through certification of skills by non-academic organizations. While assessment of learning is key to maintaining accountability in our education systems, it also comes with challenges. The design, difficulty, and frequency of assessments can have a large impact on learner motivation – especially for life-long learning (Boud, 2000). Repeated standardized exams have been found to have negative effects on student career goals and ambitions (Stiggins, 2002).

In several ways, Badges represent an opportunity to fulfill what advocates for assessment reform have desired: assessments that inform education stakeholders while also directly contributing toward a student's motivation to learn. Lorrie Shepard in her seminal address to the American Educational Research Association in 2000 called for assessments that are on-going, provide targeted feedback to the learner, are transparent, and support the creation of an assessment learning culture.

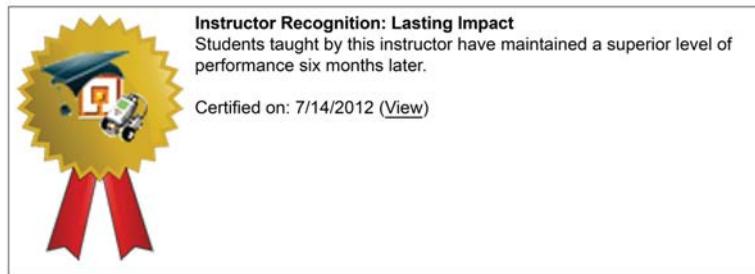
CS2N Badges are designed to preserve or boost motivational effects while also aligning with many of these assessment reform concepts. Regularly-spaced Motivation badges tied to micro-level engagement or content achievements provide on-going formative feedback. Mid-level, content-aligned Progress badges provide indicators towards mastery (i.e. targeted feedback) for individual learners. Knowledge Badges marking major achievements provide transparent assessment since their requirements are presented to all participants. Lastly, badges are highly shareable, and CS2N is committed to making its Badges part of the Mozilla Open Badge ecosystem, creating the potential for badge-based assessments to merge into a greater learning culture.

### **Badges as Feedback**

When using CS2N's activities in a classroom, teachers and students register accounts in the system and associate themselves in a Class group. This structure naturally aligns with the teacher-student relationship, and allows CS2N activities to provide the teacher with appropriately privileged information for assessment.

The existence of this relationship within the system leaves CS2N uniquely situated to facilitate two additional methods of performance-based badging: automated statistical recognition and student-to-teacher recognition.

Automated recognitions are awarded for teachers who have statistically significant positive effects on their students. Algorithms sifting through users' progress within the CS2N system can, for example, identify teachers whose students perform significantly better on a quiz, compared to students without instructors. These teachers are automatically awarded a High Performance Teaching Badge by the CS2N system.



**Figure 5: A High Performance Badge**

Many other statistical and data interaction features are detectable and awardable: a teacher whose students maintain high rates of participation after six months (see Figure 5 above), a teacher who introduces a large number of new students to CS2N through his or her class, or a teacher who successfully guides a class through an activity after attending PD for it.

CS2N's awareness of the student-teacher relationship enables additional future channels for teacher recognition: by students and by other teachers. For instance, a student could choose to recognize a teacher for help given, awarding a small badge that includes the student's description of what helped. Alternatively, another instructor could note that a student is particularly well-prepared for a course, and credit that student's earlier teachers. CS2N would keep track of the number of times these small badges are awarded, and eventually confer larger recognitions (see Figure 6 below).



**Figure 6: A Student-to-Teacher Feedback Badge, and a Larger Cumulative Recognition**

### Badges as a Global Design Document

Badges, by virtue of their high visibility and concretely defined requirements, inherently communicate expectations. This quality is valuable long before a single badge is awarded to a student or teacher. Badges in CS2N serve a critical communication and coordination role in bringing together organizations that collectively reach hundreds of thousands of teachers every year.

In order to reach as many learners as possible, CS2N collaborates with an extensive network of dissemination partners such as LEGO Education, FIRST LEGO League, the Boy Scouts, and Project Lead the Way. These organizations maintain professional development networks at scale that are already tuned to work with their particular content areas.

The end goal of the experiences these teachers train for and deliver is defined by the Industry badges that form the highest tier in the CS2N hierarchy. The idea of aligning content and delivery to industry needs is hardly new. However, the process by which they are connected in CS2N is aided by the very badges that will someday be offered to students.

Each badge forms a contract of sorts at the points where the various partners interact – the Industry badge is defined by industry partners and deconstructed by content partners to determine the best lessons and activities to use. Knowledge badges mark major learning milestones along the way, corresponding to major assessment points. Teaching badges align with the Knowledge badges, and allow dissemination partners to design appropriate curricula and professional development for their teachers. Teachers assess progress against the Badge pathway and use it to communicate expectations and progress to students and parents accordingly.

The Badge Map created during development may thus be the first time ALL stakeholders – employers, educators, administrators, education experts, parents, and students – will all be working from the same literal document in a form they can all understand.

## Conclusion

Our immediate hope for this paper is that it serves as a high-quality worked example of a badge system to advance the discussion of badge-based systems at all levels. The design features described in this paper are under development by CS2N as of early 2012, and will be rolled out over the course of the following year, then iteratively improved throughout the system's deployment. Our initial design is geared toward Robotics and CS-STEM education, and we welcome collaboration with other STEM applications. But we also believe that the continued advancement of the system will be as much a result of interactions with the greater badge, gaming, and education communities as from lessons learned in our own pilot implementations. We see this paper as a way to share our own architecture and discoveries, as well as subject it to the critique within these communities that will be vital if badge architectures are to achieve widespread legitimacy as a valuable educational tool.

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# Game-based Research Collaboration adapted to Science Education

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**Abstract:** This paper presents prospects for adapting scientific discovery games to science education. In the paper a prototype of The Quantum Computing Game is presented as a working example of adapting game-based research collaboration to physics education. The game concept is the initial result of a three-year, interdisciplinary project “Pilot Center for Community-driven Research” at Aarhus and Aalborg University in Denmark. The paper discusses how scientific discovery games can contribute to educating students in how to work with unsolved scientific problems and creation of new scientific knowledge. Based on a discussion of the concrete development of the *Quantum Computing Game*, the aim of this paper is to open a broader discussion of the potentials and implications of developing this class of games for new types of innovative science education.

## Introduction

One of the educational challenges in Western economies is teaching students to participate creatively in knowledge creation and development and to meet these challenges, the primary task of educators has been defined as preparing learners to participate creatively in the knowledge economies that most Western countries have become (OECD, 2000). In spite of the focus on educating students to actively contribute to the knowledge society, few schools teach students how to create knowledge; instead, students are taught that knowledge is static and complete, becoming experts at consuming rather than producing knowledge (Sawyer, 2006).

Games are well suited for framing complex systems and real-life settings through narratives, rule making and game dynamics. Several examples of games that simulate scientific and engineering professions exist today (e.g. Squire & Klopfer, 2007; Magnussen, 2007). The motivation for developing such games stems from a critique of the teaching of standardized skills to children in the current school system. The skills acquired in this system do not prepare them for a future that involves a constantly changing, complex work life (Shaffer & Gee, 2005). Recently, games have emerged in which players are invited to participate in real-life professional research processes, rather than simulations of them (Cooper et al., 2010). In this paper, the *Quantum Computing Game* is discussed as a working example of the implications of creating and applying what can be called ‘game-based research collaboration’ to advance innovative science education.

## Background

Game scenarios offer a medium equipped for complex simulation of professional approaches. By integrating many different aspects of real-life learning environments and framing them in a simulation, a player can identify with and relate to the experience in more concrete ways. The access to simulated professional tools provided by this type of game supports authenticity, allowing players to tackle complex problems in professional contexts (Magnussen, 2008). More recently, so-called scientific discovery games, in which players’ contributions to real-life research practice are an integrated part of the game, have been developed. In such scientific discovery games, complex scientific problems are translated into puzzles and a game-like mechanism is provided for non-expert players to help solve the problems presented (Cooper et al., 2010). A prime example is the game *Foldit*, in which gamers take part in the virtual experimental folding of amino acid chains, competing to find the protein structures existing in Nature (Cooper et al., 2011).

There are many aspects in the design of this class of game common to designing other types of entertainment or educational computer games, such as tutorial levels for newcomers and game mechanics for collaboration or competition dependent on entertainment or educational goals. There are, however, unique aspects that influence the design process in central ways when designing

scientific discovery games. The most distinguishing feature is that the solutions to the puzzles in the games are unknown (Cooper et al., 2010). The game is designed for non-expert players to advance a scientific domain and this unique challenge influences several aspects of the design. Visuals and graphics make experimentation with highly complex solutions and scientific information possible and, at the same time, must be accessible to beginners. The interactive design must make exploration processes possible but, at the same time, respect real scientific constraints. Finally, the scoring mechanism needs to award multiple player strategies while remaining true to the latest model of the scientific phenomenon in question (Cooper et al., 2010).

In seeking to adapt this class of games in schools as an educational medium for teaching students to produce new scientific knowledge and collaborate with researchers, there are also a number of design features and educational reflections that need to be taken into consideration. One such aspect could be the extension of online games to include interaction in the physical space of the classroom (such as laboratories) with scientific tools other than those in the virtual game (Hansen et al. 2010). The role and participation of the teacher is another aspect to take into consideration when designing scientific discovery games for public school science education. As mentioned earlier, one of the unique aspects of this class of games is that the solution to the puzzles is unknown. Therefore, the teacher will not have the solution to the problems that students try to solve and will need to adapt a role other than that of the all-knowing advisor. Motivational factors in this class of game are another interesting aspect and the question can be asked as to whether the prime motivational factor is for players to collaborate with researchers, or is that secondary compared to playing the game or solving scientific problems.

This paper presents the initial concept and prototype of the *Quantum Computing Game* as a working example of how scientific discovery games can be adapted to science education to allow students to work with creation of new knowledge through game-based research collaboration. The game development and research project has several objectives. First of all the objective is to solicit the help of players in solving a concrete research challenge in the field of quantum computation and similar community initiated open problems. The aim is thus also to generate a format for extensive involvement of the general public in an otherwise highly esoteric field of science. Additional to these objectives the *Quantum Computing Game* should also work as a test bed for the extension of the concept to other scientific disciplines. In this paper we examine in detail the particular challenges of a third objective in the project; to adapt the game concept to a science educational context. The first prototypes for testing are presented alongside with reflections on challenges of integrating the game into science education.

## Game Assisted Quantum Computing

The Pilot Center for Community-Driven Research that the *Quantum Computing Game* was created as a collaborative effort between researchers at the Department of Physics and Astronomy and the Department of Computer Science at Aarhus University and the Department of Communication at Aalborg University in Denmark. The development of the game thus takes place as an interdisciplinary collaboration between researchers in fields of quantum computing, learning technology, and computer science. The three-year funded Pilot Center and development of the game were initiated in January 2012 and are thus still in its initial phase. The focus of the quantum game project is the research-based production of a game-based platform for player participation in quantum computing development and research. The idea behind the establishment of the Pilot Center is thus twofold. Centre researchers want to experimentally develop both a prototype of a quantum computer and to develop the *Quantum Computer Game* in which players collectively contribute to the development of algorithms that can be implemented into the physical quantum computer.

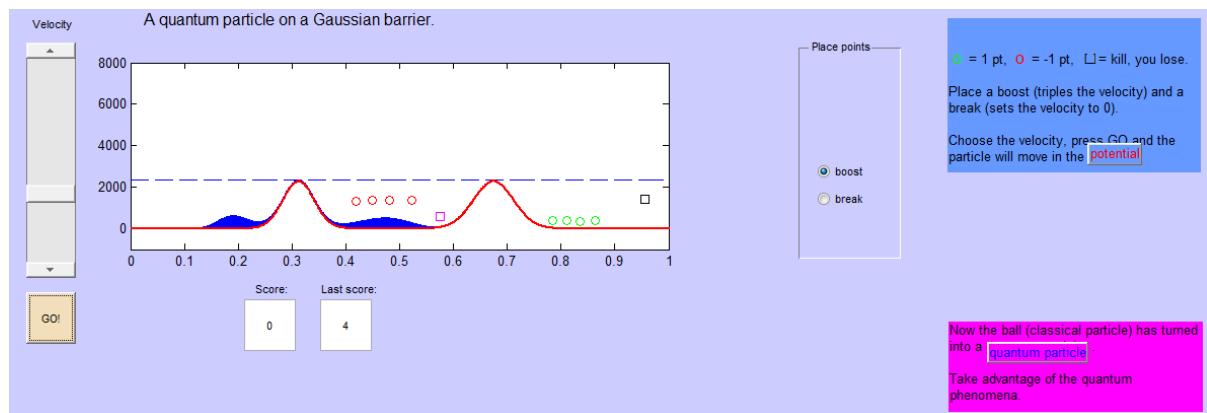
## Quantum computing

A quantum computer is a collection of 2-level constituents (quantum bits or qubits) upon which logical operations can be performed. In contrast to conventional bits, however, these qubits are quantum mechanical systems, which mean that they obey the basic rules of quantum mechanics. Here, a defining quality is the ability of systems to exist in multiple states simultaneously (principle of superposition). In particular, the qubits are allowed to be in any combination of the two levels 0 and 1 simultaneously. This means that instead of e.g. 10 bits always representing one number from  $1-2^{10}$ , 10 qubits could in a certain sense represent all  $2^{10}$  numbers at the same time and in principle perform operations on all of them in parallel. There are some caveats but the main point is that it has been proven that a quantum computer would be able to perform certain important task much faster than all

of the conventional computational power combined (Shor, 1994; Grover, 1996). This realization has spurred immense experimental as well as theoretical effort in the past two decades. Already in 2001 a working prototype of a quantum computer was developed using individual atoms in organic molecules in a solution as qubits and a technique called nuclear magnetic resonance (NMR) for manipulation (Vandersypen et al., 2001). Unfortunately the structure allowed for only 7 qubits and during the past decade this number has painstakingly been increased to slightly above 10. In a departure from the conventional approach of assembling the quantum computer one qubit at a time researchers have recently begun speculating whether ultra-cold, self-assembled crystals containing hundreds of atoms can be used to implement a large scale quantum computer. Such an architecture, where quantum software is realized by moving individual atoms around in a strongly focused tweezer of light (Weitenberg, et al., 2011) forms the basis of the scientific challenges of the Quantum Computer Game.

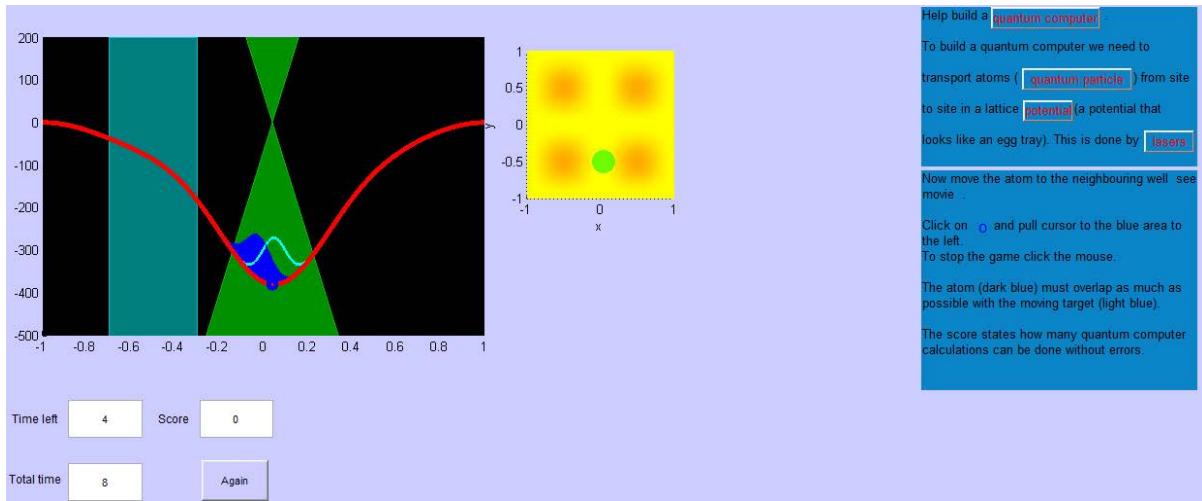
### The Game

The theme and mechanics of the first prototype of the game are grounded in research in quantum physics at the Department of Physics and Astronomy at Aarhus University in Denmark. The basic problem that players are challenged to solve is the optimization of the transportation of atoms in a quantum computer (see figure 2 and 3). The game mechanics is based on an architecture using optical tweezers for transportation of ultra-cold atoms in quantum computers (Weitenberg et al., 2011). We anticipate a community contribution on many levels. First of all, the players contribute by testing the endless number of patterns for moving atoms with the tweezers and creative solutions for solving the transportation problem, which is an extreme computational challenge for a computer to perform. This will be effective not only due to the sheer quantity but also because players can potentially apply the distinctly human skill of pattern recognition to perform a much more intelligent optimization than computers can. Furthermore, an important concept in the quantum computer game will be user participation in the initial design phase and in subsequent extensions.



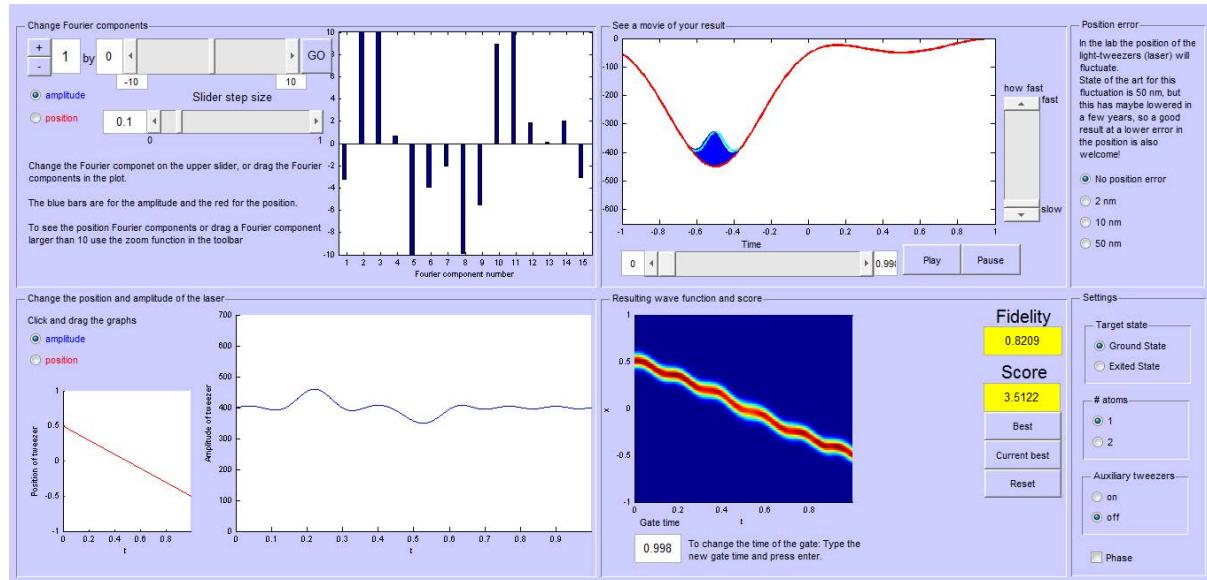
**Figure 1:** A tutorial game from the first part of the *Quantum Computing Game* illustrating the splitting of an atom in two in order to avoid the negative point (red) and only pick up the positive points (green).

The game has two parts. The first part consists of tutorials in which players are introduced to aspects of quantum physics and learn how to manipulate game mechanics (see figure 1).



**Figure 2:** A scientific game from the second part of the *Quantum Computing Game* where players move the atom from a well on the right to a well on the left. The aim is to realize the transport with minimal sloshing of the atom.

Players can continue playing games in the tutorial part or they can move on to the advanced part. (see fig. 2 and 3) to start solving real research problems and have their performance logged.



**Figure 3:** An advanced scientific game in the second part of the *Quantum Computing Game* where the motion of the tweezer can be controlled globally.

In the *Quantum Computing Game* the key scientific objective is to develop algorithms with small enough error probability to allow for quantum computations on a large scale without errors piling up. For each attempt, a score is calculated based on the quality of the resulting quantum computer. All players' performances are logged centrally and the global high-score will always correspond to the state-of-the-art of the research field, which can thus be extended for each hour dedicated people play. The game also allows for players to develop their own sub-games and participants can thus both contribute with computing power, but also take part in a continuous development of the game.

### Methods and the first development phase

The design of the game and interventions is set up in a design-based research process (Brown, 1992). The first prototype was developed to establish an interface from which players could develop algorithms as candidates for implementation in the quantum computer. As the project group had little knowledge on the motivational factors and suitable interfaces for manipulating the scientific

information, it was decided to do a rapid test of a first rough prototype to provide initial data for the further development of the game. By testing the first prototype, both online and in classrooms, data on player interaction, and experiences in both settings will be collected and used in the development of the next version of the game. Interventions with the first prototypes was completed in February and March 2012, in which video observations of game playing in two high school classes and surveys with teachers and students was collected. The collected data from these interventions are still under examination. An online test phase is currently being conducted with approximately 100 volunteer beta testers in order to log and collect test data and do surveys at different stages of the game.

In this first phase of the project, the project group discussed the interface and whether it was accessible for the target groups. In the context of this paper the target group of relevance is high school students with physics on a high level, or players on a more advanced level. It was discussed whether the visuals and graphics made the game accessible to beginners, even of this more advanced target group. The potential motivational factors for players were also discussed. Following a promotional effort, science teachers from different schools contacted the project group to volunteer to be part of the first game tests. The overall motivation for these groups seems to be the opportunity to contribute to quantum physics research and to collaborate online with researchers. The project group also discussed whether the game interface should be further developed with visuals of real-life tools and experimental settings to enhance the player experience of working with quantum physics researchers. Another question is whether to expand the game-play with other possible modes of experimentation, as atom transportation actions may be too narrow to support different types of creative player experimentation. The question of whether the visuals and graphics support the player experience of experimenting with complex solutions to quantum physics problems and at the same time is accessible to beginners will also be part of the first tests of the game. These observations will also focus on understanding how the game experience could be enhanced and deepened as an integral part of science education and what additional interactions, experiments and tools could be included in the educational version of the game.

## Conclusion

This paper has presented a concept for and a working example of the *Quantum Computing Game* as a framework in which students can experiment with unsolved scientific problems and contribute potentially new solutions to real-life research questions. As described, the game is in its first phase of development and the results presented here are quite preliminary. The purpose of presenting the project in this early stage of development is to initiate a discussion on how game formats that support student experimentation and creation of new knowledge in science education may be created and employed using the *Quantum Computing Game* as an example. How this kind of game development implicates an adaptation of the online format for the school setting that includes teacher roles, physical classroom settings and different types of tools were also discussed. The most distinctive aspect that distinguishes this class of games from other educational game formats is the lack of concrete solutions to the scientific puzzles presented in scientific discovery games. This of course makes scientific discovery games highly interesting in a science education context as they provide a medium for students to work with open-ended experimentation and to contribute to real research at a high level, a potentially strong motivator for some groups of students.

Compared to the graphically-rich formats of science games that simulate professional working processes and professional values, scientific discovery games can be in danger of only appealing to students already interested in the specific science concept presented. The highly-technical visuals and graphics characteristic for scientific discovery games are unlikely to appeal to students not already interested in the subject area. Scientific discovery games are often highly specialized since they are framed by the areas of interest of researchers. One possible solution for making the format accessible to a broader group of students is to extend and combine the possibilities of game-based research collaboration with the rich environments available for the many types of interaction that professional simulation games pose also involving metaphorical models for the simulations. This could also strengthen the focus on professional values, tools and thinking processes as part of student work with scientific problems and innovation.

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# Pathfinder: Developing prototypes towards an engaging game to reduce implicit bias

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**Abstract:** Educational games have a reputation for being lackluster. Striking a balance between good game mechanics and teaching specific content is something that few have been able to accomplish. In this paper, we will discuss some of the challenges that we faced during the creation of *Pathfinder*, a game funded by a grant from the National Institutes of Health, that aims to decrease implicit biases against underrepresented individuals in academic science, technology, engineering, mathematics, and medicine (STEMM). We will describe three iterations of the game to illustrate how we are working toward balancing content and gameplay with a specific focus on how to make a game about a sensitive social issue fun to play. This is our story of making a little game with big impact, called *Pathfinder*.

## Introduction

*Pathfinder* is a game designed at the Morgridge Institute for Research 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 game is intended to be played by faculty in these fields on a web platform.

Everyone has implicit biases, but what is interesting about them is that they can be markedly different from ones' personal beliefs. Implicit biases come from stereotypes that we all learn from our culture, and even if one does not consciously endorse them, they may still act on them (Devine, 1989). For example, while most would consciously state that men and women are equally qualified to hold academic positions, our behavior is different when our unconscious beliefs are assessed. Research has shown the majority of us have an easier time associating males with science and females with the liberal arts (Nosek, et al., 2007). We also have an easier time associating males with career and females with family. Similarly, implicit biases extends beyond gender, as studies show that the majority of Americans have more negative implicit associations with African Americans than with Caucasians (Nosek, et al., 2007).

The good news is that researchers have found ways to reduce implicit biases. One strategy involves consciously taking the perspective of someone from a stereotyped group. While this passive technique can be effective, video games, as an interactive medium, could be a more potent approach. For instance, video games that are successful at immersing their players in a constructed world, are also fostering their players to identify and empathize with the main character (Schell, 2008). James Paul Gee (2003) calls this "projected identity." According to Gee, for a player to become immersed in the game, they must connect their real-world identity with a virtual identity that they project into the game character. In *Pathfinder*, we are attempting to utilize the players' projected identity to address implicit bias, by having players imagine themselves as a young African American man in academic STEMM.

*Pathfinder* players assume the role of Jamal, a young African American graduate student, on his journey to become a renowned professor. To succeed in the game, players must maintain a diverse academic social network while running a research lab. The research lab gameplay entails collecting crucial research data and securing grants to pursue scientific discoveries. Over the course of the game, players will interact with a diversity of people from academia who can assist Jamal with the ultimate goal of becoming a renowned professor. It is through these social interactions, as a form of roleplay, that *Pathfinder* simulates real-life bias encounters. By experiencing bias as Jamal, we hope our players will gain tacit knowledge (Gee, 2003), which when combined with various bias reduction strategies demonstrated in the game, will lead our players to incorporate their improved awareness and new skills into their daily lives.

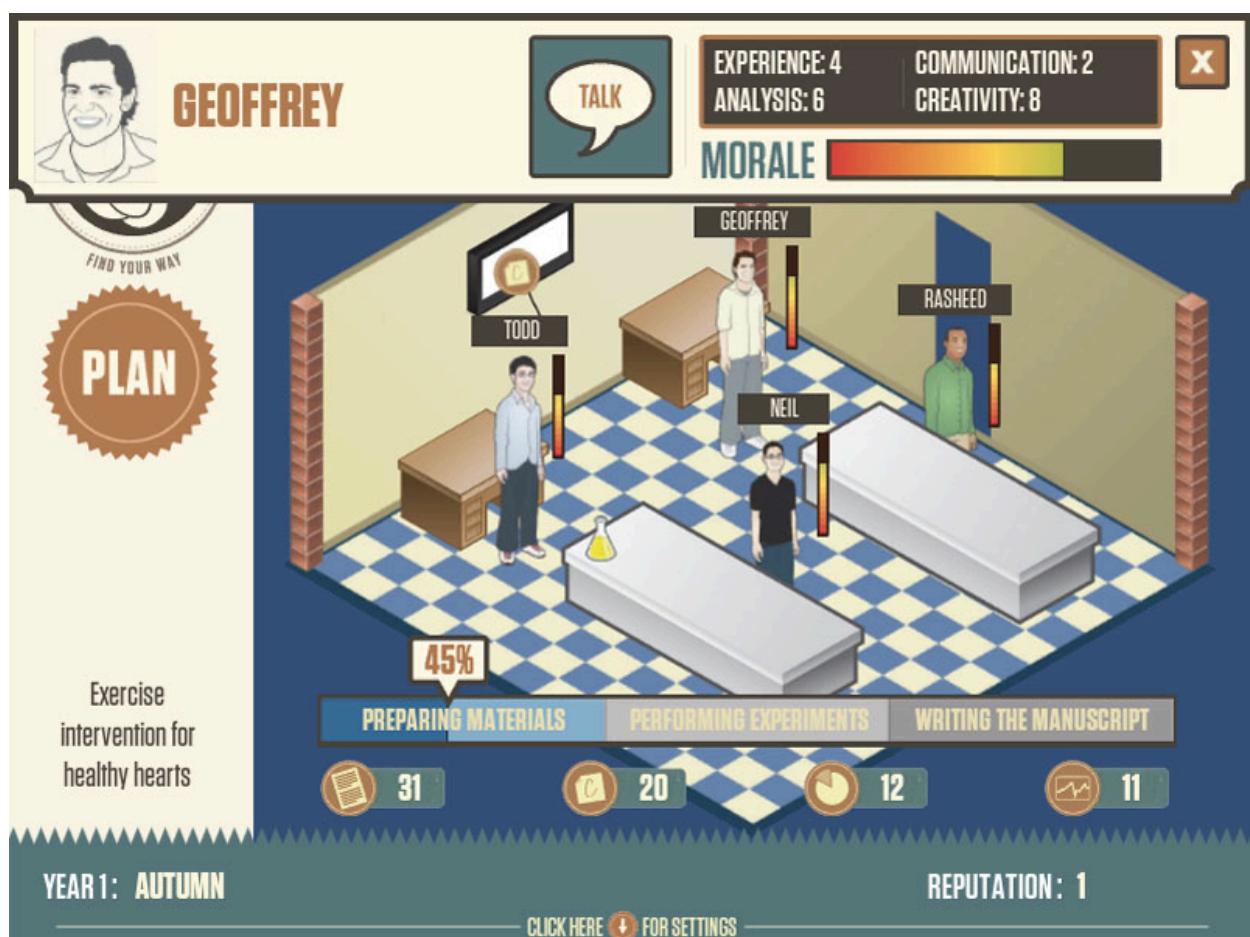
## Rapid Prototyping

Rapid prototyping is an approach to game development that can be particularly useful for small development teams or independent game companies because it allows for a succession of small goals to be reached in a short period of time. Rapid prototyping involves the quick development of tangible and usable artifacts so that they may be revised and reiterated. The following is a critical review of some of the

prototypes created during our development process. We will describe three iterations of the game to illustrate how we are working toward balancing content and gameplay, with a specific focus on how to make a game about a sensitive social issue fun to play. For each prototype, we will talk about what worked, what didn't, and what we learned from the experience.

### First Prototype

One of our first goals was to make Pathfinder a game that faculty members could relate to. We wanted to create scenarios and characters that were believable and would allow for faculty to develop a projected identity. In order to do this, we put together a group of content experts from various fields within academic STEMM. We met with them regularly to get feedback on the storyline, setting, and characters. The resulting prototype was a game based on managing a research lab in which players dealt with bias situations that arise in the lab. In this game, players evaluated resumes, hired grad students, and submitted to journals. In order to draw attention to implicit bias during game play, the research lab's morale was effected by players' decisions. If players handled an event poorly—for example, they didn't diffuse a situation that stereotyped African Americans—the non-playable characters (NPCs) involved would decrease their performance in the lab. This version of the game successfully introduced bias in an academic setting, but soon faced a series of problems.



**Figure 1: Screenshot of the lab in the first prototype.**

One hurdle that we faced was taking for granted that our audience would be accustomed to standard web conventions. Because, for most of us, this was the first time developing for a non-gaming audience, we took for granted features like disabling buttons when they're not need. This resulted in confusion during the playtest that distracted some players to the point that they didn't engage with the game (or the content). We had not anticipated this response, but used this feedback to inform decisions during future iterations in order to make them more accessible (e.g., font size). On the same note, visual feedback was also in need of refinement during this iteration. During the playtest, some players reported that they didn't feel like their decisions affected the game much. This was due partly because the visual indicators were subtle. Even if a decision had dramatic consequences, a playtester who had never played the game before would have no way to determine if their decisions affected the outcome, or if the same outcome would have been

achieved regardless. The lesson learned here was to make sure that visual indicators, whether they are meant to navigate or to indicate the player has done something meaningful, are explicit.

Another problem didn't manifest itself as a problem at first. Because we knew that making our scenario as relatable as possible was important, we took feedback about this very seriously. If our content team felt something wasn't true to academia, or if it was too far-fetched, we modified the game to reflect these ideas. This led to a game that involved applying to several journals, managing undergraduates, writing papers, collecting data, and writing grants. Development in this direction continued until playtesters reported that they felt the purpose of the game was to introduce graduate students to the world of academia, not informing players about bias in an academic setting. We soon realized that we had tried to incorporate all the feedback given to us by the content experts and, as a result, spent more time creating an academic simulator than we did a fun game about bias. This taught us a valuable lesson: keep the goal of the game in mind and seek feedback that helps to emphasize the core experience.

## Second Prototype

As game designers, another goal for us was to create a memorable experience for players that would help them understand various forms of implicit bias. Keeping this in mind, for our second prototype, we focused on trying to make players feel what it is like to be an African American man in academic STEMM. We wanted them to experience subtle biases and microaggressions as if they were Jamal. As Jamal, we wanted the player to experience biases others may have about them solely due to their skin color. We also wanted them to consider that, in addition to the typical challenges that one faces in academia, individuals from underrepresented groups may also have to overcome the obstacle of implicit bias.



Figure 2: Screenshot of the lab in the second prototype.

Due to the lessons we learned in the previous prototype, we revisited the lab portion of the game and proceeded to make it less of an academic simulation, and more of a time management game with an academic theme. We then focused on emphasizing the implicit bias content of the game. Explicit information about implicit bias was an element that was missing from the first prototype, which again focused on subtlety. Because there is a wealth of information about implicit bias available, the challenge became: How do you convert mounds of text into engaging game content? This resulted in the creation of

a conference portion of the game. Our idea was that we would have a fast-paced time management game act followed by interludes where the main character, Jamal, attends academic conferences and talks to peers. During these interactions, we would introduce the players to implicit biases via conversations with the NPCs. Through playtesting, we soon found the strengths and weaknesses of this approach.

While the conference portion of the game seemed like a great vehicle to deliver content, playtesters found the interactions within the conversations to be lacking. On the one hand, we were able to provide players with the emotional experience we were seeking. Some of the playtesters were genuinely disturbed with the way they were treated in the game by the NPCs and found it unsettling that the content had been generated from real events. On the other hand, players felt that they lacked agency. They thought the game was too didactic and described the interaction as “flat” and “linear.” As a result, we have taken steps to make the conversations in our current prototype more interactive while keeping the instances that triggered genuine emotional responses.

Another problem that arose during playtesting was the lack of cohesion between the lab portion of the game, and the conference portion. Playtesters felt as though they were playing two separate games, the “lab game” and the “conference game.” This is a very real concern that is often overlooked by developers of educational games. Because we had no clear way to deliver the bias content in the lab portion of the game we had essentially used it as a carrot that led players to the content. Due to the disjointedness of the two portions of the game, players felt that their choices in either portion were not meaningful. A true game doesn’t sandbox the content, but instead makes it an integral part of the experience. This cardinal rule of game design was somehow overlooked while trying to fit in all the content we wished to show the player, luckily playtesters held us accountable for the fact that an educational game should be a game. This is perhaps one of the best pieces of feedback we’ve received from our playtesters and we have taken steps to emphasize this integration in our current build.

The final lesson that we took away from this prototype is to let players determine whether a game is good or not. Although this is not a new lesson to many, it’s difficult for designers to remove a good idea that just doesn’t seem to work. In our case, we believed that allowing players to play the game first as both a Caucasian graduate student (Geoffrey) and an African American graduate student (Jamal) was appealing, as they would take on the perspective of both Geoffrey and Jamal to compare and contrast their experiences as they progressed through the game. Our hope was that this contrast would highlight biases that might otherwise be overlooked in these situations. When we playtested this, however, we found that the contrasts were not as profound as we had hoped they would be, with the only measurable contribution being more gameplay with content that wasn’t unique enough to merit another playthrough. As a result, we cut our losses and focused on Jamal’s story which seemed to invoke a strong emotional response from most of the playtesters.

### **Third Prototype**

As we continued further development of the game, our third prototype took into serious consideration the comments that were consistent across most our playtesters, comprised of content experts, members of our target audience (STEMM faculty), and individuals who identified as active gamers. As mentioned previously, a glaring issue that surfaced in our second prototype was that the lab and conference portions of the game felt disjointed to most players. Both Jamal and Geoffrey first began in the lab writing papers then they were shuttled off to a conference where Jamal encountered bias scenarios that Geoffrey didn’t. The work that both characters had accomplished in the lab was insignificant during the conference, and their interactions during the conference were useless for advancing in the lab.

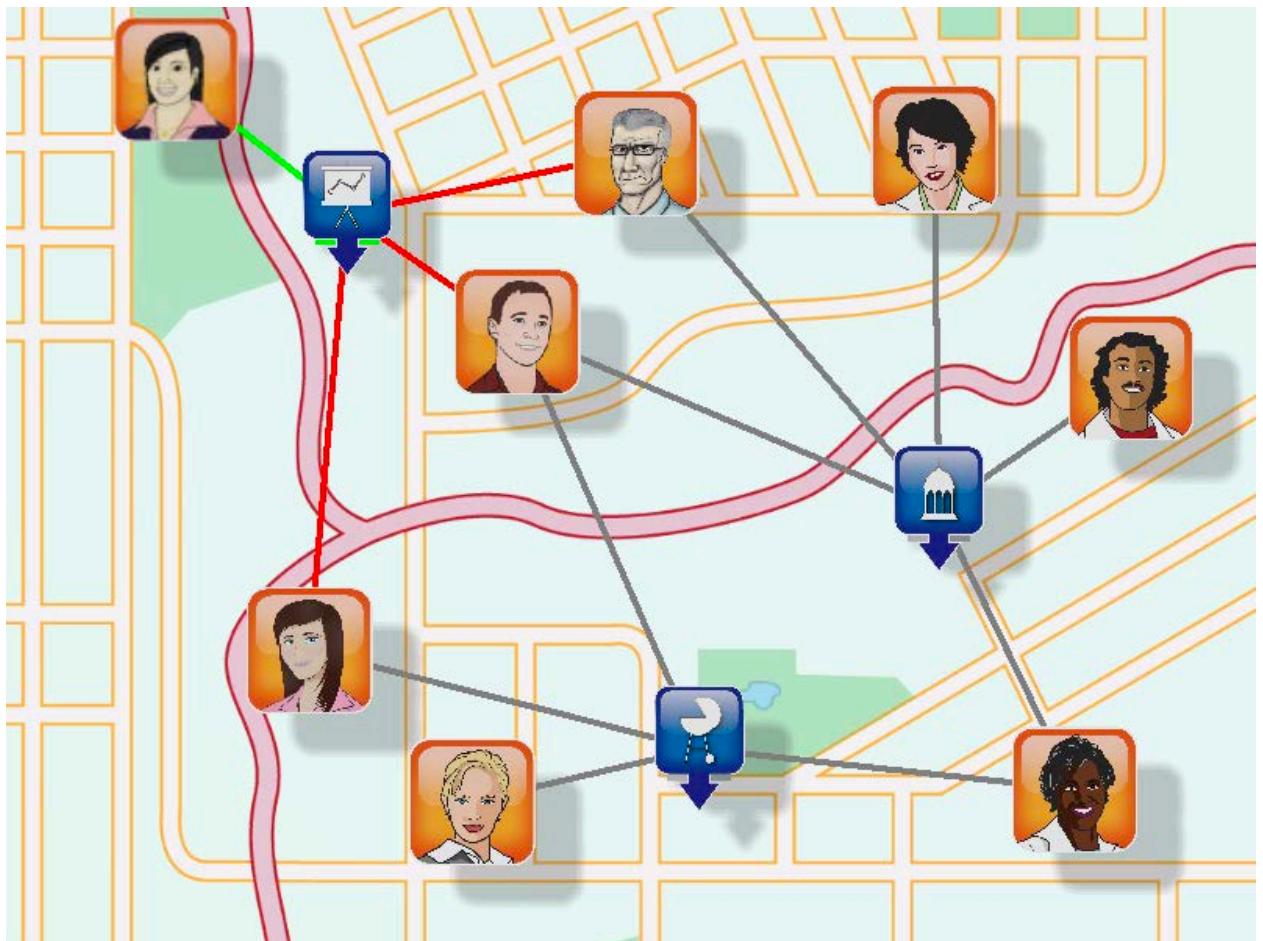
Given this feedback and more time to elaborate on the game, we expanded our third prototype in numerous ways. First, we ditched the comparison gameplay, where the game illustrated the differences in Jamal’s and Geoffrey’s experiences with implicit bias at the conference. Because our playtesters found Jamal’s experiences compelling on their own, we removed Geoffrey from the game to focus solely on Jamal’s story. This requires players to take the perspective of only one character, allowing them, as Jamal, to build deeper relationships with the NPCs over time.



*Figure 3: Screenshot of the lab in the third prototype.*

We introduced a handful of new features in our third prototype. The introduction of two more locations (another lab on campus and a department barbecue), as well as four new NPCs (the second prototype only had three), means that Jamal can interact with some of the same NPCs at different locations. This gives players the opportunity to learn more about each NPC over time, giving these NPCs a certain richness and dimension. While playtesters enjoyed the conversations in the second prototype, they found the dialog choices meaningless. For the third prototype, we retained a similar conversation system, but made the choices meaningful by increasing or decreasing stats for certain characteristics (such as friendliness and respect) for each NPC, depending on how players choose to proceed during their interactions with them. We directly tied these NPC stats to the lab portion, where Jamal would gain upgrades or unlocks that will help him perform more efficiently in the lab. This solution is one of the few ways in which we've knit more tightly the two portions of the game.

New locations and new characters called for an in-game system to maintain them. In the lab portion, we incorporated a calendar to keep track of upcoming events (including the conference, lab visit, and barbecue), a map to show the locations where NPCs will visit, and an elaborated social network, SciConnect, where Jamal can maintain his contact list -- those he met at locations. Given these changes so far, Pathfinder, for the first time, begins to feel more like a fuller game for us, rather than an academic simulator (first prototype) or a bias victim simulator (second prototype).



**Figure 4: Screenshot of the map in the third prototype.**

The challenge of integrating bias content explicitly throughout the game remains – there is a plethora of research on implicit bias, but how can we do all this literature service by showcasing it, and where will it all go? We introduced an almanac in the second prototype that we have kept for this third prototype. High-level, academic text such as detailed descriptions of bias concepts and citations for further reading continue to be relegated to the almanac. However, the almanac has been restructured to show jargon-free descriptions and especially to show game examples as they are encountered by Jamal, to serve as a reminder of players' experiences. Additionally, each NPC is associated with only one implicit bias concept. This one-NPC-to-one-bias ratio is ideal because it allows players to witness the evolution of a bias concept and see how it manifests in different contexts/locations. Recognizing an NPC also means that players recognize a type of bias as well, rather than asking players to remember all the bias concepts across all the NPCs. Whether this gameplay is effective is yet to be determined, as we intend to playtest this prototype in Spring 2012 and, at the same time, begin development on our fourth prototype given our players' feedback.

## Conclusion

The cycle of rapid prototyping and playtesting has been a valuable development approach for our team, and has lead us to create a game that is more attuned with for our target audience than ever before. Reaching this stage has been an invaluable experience as we continue to learn the strengths and weakness of video games as a interactive medium. Despite our success, making a fun game that anticipates our audience's reactions while utilizing the latest research remains an ongoing challenge. Through all three prototypes so far, we struggled with balancing gameplay and content.

In this worked example, we discussed at length the challenges we faced in developing each prototype, complicated by some differing, but valuable, feedback from our playtesters. As we work towards a completed product, we intend to produce frequent builds for our team of content experts to assess, pillared by frequent playtests. Additionally, our next steps include running a full research study on a polished version of our third prototype through Spring and Summer 2012.

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## ***Operation MHNIΣ:*** **Mapping learning objectives to play objectives**

Roger Travis, Stephen Slota, and Kevin Ballestrini

**Abstract:** In this worked example, we examine the UConn game/course *Operation MHNIΣ/CAMS1101 “Greek Civilization”* as an illustration of the problem of ruleset-mapping in learning games. Through an example of a crucial humanities learning objective, textual analysis, we explore the idea that key affordances of game-based learning come from rules and not from content, whether that content is 3D graphics or physics facts. The format of *Operation MHNIΣ*, in which an alternate-reality game encloses a role-playing game, permits a ruleset that fosters culturally-sensitive textual analysis as an essential element of the course’s gameplay. We suggest that the importance of achieving learning outcomes in skills like textual analysis may make low-tech text-based games just as successful as (if not more successful than) video games at producing favorable student outcomes.

At the 2011 Games+Learning+Society conference, a team from the University of Connecticut led by Roger Travis and Michael Young presented their work on a learning game called *Operation LAPIS*, whose most distinctive feature is that it represents a full curriculum in introductory Latin: the game is the course and the course is the game. In this worked example, we explore the founding principle of *Operation LAPIS* in another game/course. We examine the theory behind the principle that mapping play objectives onto learning objectives lets rulesets themselves foster learning, and suggest its implications for practice, in the context of Travis’ game/course called *Operation MHNIΣ* (say “MEH-nis”), a game/course both in Greek civilization and in introductory Greek.

Like *Operation LAPIS*, *Operation MHNIΣ* presents an important challenge to the game-based learning community. It does not look like a video game. Indeed, we believe it calls into question the usefulness of video games for learning higher-order skills like analysis and interpretation. Salen and Zimmerman (2003) argue persuasively in *Rules of Play* that immersion in games comes from rules and not from visual or spatial interaction; the UConn group’s research strongly suggests the same conclusion based on humanistic inquiries in Homer and Plato (Travis, 2011a), which also suggest that this rule-created immersion creates powerful affordances for learning (Travis, 2011b). Further, a meta-analysis of research on video games in education by a UConn team suggests that the areas of promise in video game-based learning arise in games in which the rules themselves (e.g. “Speak the target-language”) embody the learning objectives (Young et al., in press).

However, if immersion comes from rules and thus the bundles of rules we call “mechanics,” what kinds of mechanics could possibly teach students to analyze literary texts? Behind *Operation MHNIΣ* lies the idea that humanistic learning objectives like culturally-sensitive textual-analysis can be mapped onto play objectives through well-designed rulesets in a one-to-one relationship so as to foster this crucial skill. This idea, which the UConn team calls the “practomimetic principle,” is based on an insight arising from a ludic analysis of homeric epic and Platonic philosophy that indicates that, to put it simply, games teach their rulesets, not their content.

Roger Travis has explored the classical, humanistic underpinnings of what he calls “practomimetic learning” in several publications (e.g. Travis and Young, 2010; Travis, 2011b), and has written extensively about the relationship between the insights to be had from a comparative analysis of classical literary forms and modern games, and the development of game-based curricula (Travis 2010). Travis sees homeric epic’s role in the educational practices of ancient Athens, together with Plato’s critique of that role, as presenting modern learners with an opportunity for a kind of game-based learning that reawakens the powerful affordances of classical epic and philosophy both for educational institutions and for our communities more generally.

If games teach their rulesets, however, the game-based learning community has a problem. The games we think of when we say Games+Learning+Society—that is, video games—do not have rulesets that teach humanities learning objectives in the upper tiers of Bloom’s taxonomy (Bloom, 1956; Anderson and Krathwohl, 2000). Clicking on evidence to assemble an argument, for example, as the mechanics of several stat-of-the-art learning games have run recently (e.g. Filament Games’ *Resilient Planet* and *Argument Wars*), is not the same thing as constructing an argument. The mechanics of these games allow players to change the game-state not using analytic skills but rather using skills of recognition and identification. If games teach their rulesets, the student may learn to recognize a piece of evidence, but

s/he will not learn to use it analytically. If we want to be able to design games that teach analysis and creativity with texts, for example, we need to find a different kind of ruleset.

The development of our example, *Operation MHNIΣ*, reflects a potential solution to this problem. Through a situated cognition framework, we have adopted a learning-by-doing model wherein students must problem-solve, create, and capitalize on other 21st century skills that reflect knowledge as action specifically in order to master learning objectives in the domain of textual analysis (Brown, Collins, and Duguid, 1989). The game is an RPG wrapped in an ARG: by forcing students, playing as operatives at the ARG layer, to analyze on the one hand the text-based narrative in the RPG-layer, and, on the other, the “text-briefings” of the game (i.e., the reading of the course), the game uses its ruleset to foster the achievement of higher-order learning objectives associated with deeply contextualized problem-solving (Bransford and Stein, 1984; Polya, 1945). Rules are mapped to learning objectives in a one-to-one relationship: papers become mission-briefings; detailed textual analysis becomes intelligence gathering; collaborative annotation of classical texts becomes fieldwork for developing virtuosic role-playing performances.

For this reason, *Operation MHNIΣ* does not look like a video game. If anything, it looks like a text-adventure accompanied by a series of supplementary texts. Students/players spend most of their time conducting analyses of the Greek texts that are always at the heart of the learning goals for a course in Greek civilization: Homer, Herodotus, Thucydides, Aeschylus, Sophocles, Euripides, Plato. These analyses result from a ruleset that imposes analysis as a mechanic—that is, a bundle of rules that controls the relationship between player-input and game-state (Ferrari, 2010). When students input their analyses in the team-workspace forum, they receive points, and when they input role-playing performances governed by that analysis in the text-based RPG, their characters receive rewards.

The unification of instructional-design and game-design implied by the practomimetic principle means learning activities become themselves the mechanics by which mastery is both achieved and measured. The mechanics of the game/course foster progress towards learning objectives in the domain of textual analysis by making the reading itself the game/course’s fundamental activity/mechanic: reading, and analyzing that reading, is the fundamental activity of *Operation MHNIΣ*.

For example, three complementary mechanics foster achievement of the learning objective “culturally-sensitive analysis of classical literature”: the annotation mechanic, the collaboration mechanic, and the immersion-response mechanic. The first of these mechanics takes place in the ARG layer, as student-operatives team up as an entire class to annotate for example the text of the homeric *Iliad*; the second takes place between the ARG and RPG layers, as they divide into their character-teams to collaborate on what their characters will do in the RPG based on their annotation of the text; the third takes place inside the RPG, as the lead operative for a given immersion posts his or her team’s character’s actions in response to the action in the text-based simulation of the ancient world.

So when the student-operatives approach an RPG situation early in the game/course in which their characters must prove to the homeric rhapsode Ion why he should talk to them about the ancient notion of excellence (see Figure 1), their text-briefing, as the reading is called in-game is from the homeric *Iliad*, and they must annotate it collaboratively in Google Docs as MHNIΣ operatives (see Figure 2).

“Doesn’t ο ἐπώνυμος look troubled?” λέγει the first ἄνθρωπος, jerking his head πρὸς where a stately-looking figure waits ἐν the long shadows τῆς στοᾶς. “Never knew he had any connection πρὸς Σωκράτην.” The stately ἄνθρωπος does indeed wear an expression of anxiety.

Νομόκλης gestures πρὸς you to huddle-up with him. Once you are all leaning in, Νομόκλης λέγει, “You must go talk πρὸς Ίωνα; έστι how this must begin.”

In fact, Ίων appears to have noticed your huddle. “ὦ Νομόκλης!” λέγει imperiously. Bring those young men over here-- they’re οι Κεκροπίδαι aren’t they? έστι well they’re here; they can learn a great deal this morning.”

Νομόκλης λέγει softly, “Ίων έστι ράψωδός. You’re going to need to show him that you know Όμηρον.”

*Prompt: Using an analysis of the words of R121 together with the supplementary information found in the Codex, persuade Ίωνα λέγειν to you what he thinks you can learn.*

**Figure 1: RPG immersion-prompt**

In Figure 2, we see Operative Traffic (not his/her real name) beginning the arduous process of mastering the concept of double-determination, an absolutely key learning sub-objective for doing culturally-sensitive

analysis of homeric epic. We also see the two kinds of feedback offered by the text-based mechanics of the course/game: the instructor's scaffolding feedback and the experience point system, called "Hellenism Points" in *Operation MHNIΣ*.

, who knew things  
eans with their fleet  
With all sincerity

will therefore do  
deed, for I know  
ans are in  
allow his  
ore, whether or no  
  
eaven, for by  
Danaan at our



The screenshot shows a text-briefing annotation interface. On the left, there is a large block of text from a player. On the right, there are two messages from the instructor, OperativeTraffic and RogerTravisJr.

**OperativeTraffic**  
10:21 AM Jun 1, 2011  
Achilles must have some sort of connection with the gods if he is "loved" by the heavens

**RogerTravisJr**  
10:41 AM Jun 1, 2011  
Very interesting question. Is he an epic hero because he has a special connection, or does he gain the special connection because he's an epic hero? We'll be talking a lot about the true role of the gods. 100 HP

**Figure 2: ARG text-briefing annotation**

In turn, students/players use this ARG information when crossing the divide between ARG and RPG, in their team-workspaces (see Figure 3).

**Re: TSTT122 collaboration**

by OperativePane » Wed Jun 01, 2011 5:45 pm

Prompt: Using an analysis of R122, champion κλέος--or side with the young man. So I'm thinking that the portrayal of Hector in book 6 supports κλέος, because he believes that his fate is out of his hands, so the most important thing is to have a meaningful life and strive for glory.

In contrast, the young man represents Achilles' way of thinking, because they both place little value on glory. Achilles would rather live a long and enjoyable life instead of risking it for κλέος. Supporting this, the young man thinks that fighting for glory's sake was not worth it, because defeat has caused a decline in current conditions.

I think that Αγαθόβουλος, our citizen would champion κλέος, rather than side with the young man because he has promised to avenge his father, which, in my opinion, indicates that he plans to fight for κλέος in the name of his father.

What are your thoughts on this? After you give me some input, I can put it together more formally.

**Re: TSTT122 collaboration**

by xenos » Wed Jun 01, 2011 5:48 pm

Really nice start, operative. Text-analysis plus worldview=ΜΗΝΙΣ-awesomeness.

MENIS\_MCx\_offline

δοῦλος τοῦ Δημιούργου είμι



**xenos**  
Chief, Mission Control

Posts: 1555  
Joined: Mon Nov 01, 2010 11:50 am  
Location: APXAIA HQ

**Figure 3: Team textual-analysis**

Operative Pane (a student-selected pseudonym) brings what s/he learned through annotating the text-briefing into the space between the ARG and RPG layers; the authentic learning of concepts that would seem far removed from the player/student's life happens effortlessly here in the interstices of the game/course's ruleset. This player/student is the "lead operative" for this particular immersion-session, and so is tasked with organizing the collaboration; unsurprisingly, player/students' growth is greatest (at least as measured in the number of HP awarded) when they must serve in this capacity.

This mastery of text-based learning objectives translates directly into the character-teams' response to the immersion session, as seen in Figure 4.

**Re: TSTT121**

by OperativeTraffic » Tue May 31, 2011 9:53 pm

"Ιώνα we know that in order to get what you want you must be respectful και non-threatening for you will create some sort of peace between each other. Using harsh tones και intimidation will create enemies και we must all work together in order to do what is best for all. As seen prayer to the gods έστι a necessity in order to succeed και do well for others. δεῖ to pray to Ares in order to attain what the necessities for war. Prayer έστι said to the many different gods in order to obtain information for the coming battles as well as what would be the right course of action. For the sake of Athens, your information must be divulged because Ares came to me in a dream, and informed me to receive this information lest he bring war to Athens.

**Figure 4: Player/student immersion-response**

As lead operative of the character-team for the team-character called Stratomedon, a team tasked with bringing to life a young Athenian warrior, Operative Traffic shows, through a performance exercise, authentic beginning mastery of the terribly complex ideas behind the way Greek religion functions in literary texts.

These examples might invite the reader to ponder the full implications of James Paul Gee's famous carefulness about asserting that video games are in and of themselves good learning tools—for example, “Game design is applied learning theory, and good game designers have discovered important principles of learning without needing to be or become academic learning theorists” (Gee, 2008, p. 24). Video games may embody principles of learning, but the kind of learning that video games enable must always depend on the learning objectives embodied in their rulesets. In a classics course—or, really, any humanities course—textual learning objectives are the name of the game, quite literally. We would submit that there is a need for similar constraints, embodied in rulesets, whether of a textual or perhaps even of a chemical or statistical nature (that is, in courses in chemistry or statistics), for any game that seeks to foster accomplishment of key learning objectives in an established academic domain.

Indeed, the ruleset-mapping found in *Operation MHNIΣ* allows its mechanics to foster mastery of its learning objectives and exposes itself as a constructed ludic artifact, allowing its players access to a meta-cognitive perspective on both their play and learning. The ARG layer of the operation, as an extension of the practomimetic principle, makes students operatives; as operatives they become players of the RPG layer of the game: in order to accomplish the play objectives of *Operation MHNIΣ* they must also accomplish a fundamental learning objective that we believe may be unreachable in any other kind of course of study: save the world by gaining an education.

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## **Reality Ends Here Design Brief: An Environmental Game for Media Arts Students**

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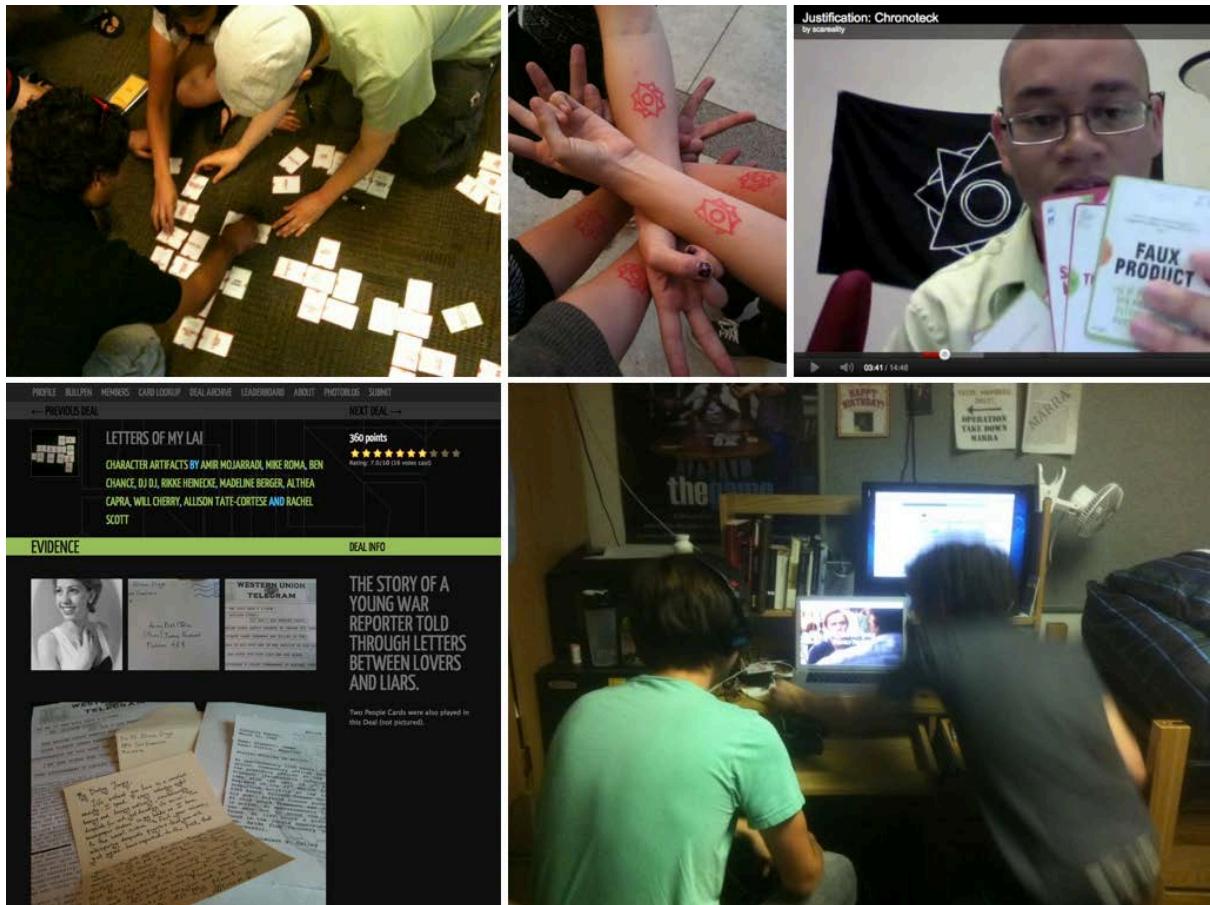
**Abstract:** *Reality Ends Here* is an environmental game designed to effect immediate change in the community of learners at the USC School of Cinematic Arts (SCA). Over the course of the project's 120 day run, collectible cards, rumors, secret websites, and a mysterious black flag drew more than 150 students into an intense voluntary underground social game involving collaboration, strategy, and artistic experimentation. By connecting students to one another in unpredictable and serendipitous ways, and by providing a framework for meaningful play and performance, the game transformed a collection of heavily siloed academic divisions into a productively chaotic and interdisciplinary community of practice. This paper introduces *Reality Ends Here*, defines the emerging practice of environmental game design, and discusses the central role of player agency in the design of the experience.

### **Introduction**

[Reality Ends Here](#) is an environmental game designed to accelerate serendipity, social discovery, and collaboration among students in the disparate divisions of the USC School of Cinematic Arts. It employs a wide range of technologies and practices, from a game system driven by digitally-connected collectible cards to a web interface integrated with Facebook, Twitter, YouTube, and other social media platforms.

Gameplay in *Reality Ends Here* takes place in every corner of its players' lives, as they collect, share, trade, and combine game cards in order to generate creative prompts which are then used to guide the making of unique media artifacts and the staging of real-world events. By sharing the resulting creative works through the social media platform at the center of the game, players connect with one another across disciplinary and institutional boundaries and unlock customized "trailheads" leading to intimate and offbeat encounters with SCA alumni, artists, and other industry professionals.

The 2011 implementation of *Reality Ends Here* produced a tangible positive impact on the culture of the SCA over its 120 day run, bridging the gaps between traditionally siloed disciplines, generating a rich archive of creative works and fresh assessment data for an entire cohort of freshmen, and creating an atmosphere of intellectual and artistic experimentation. The second iteration of the game is scheduled to launch in August of 2012.



**Figure 1: Reality Ends Here, various play contexts.**

Henry Jenkins describes the impact of the game as follows:

[This] is the first time I've seen such a large scale experiment in integrating [game] activities across an entire school to orient entering students to a program and to serve a range of instructional goals. The passion the game is motivating in USC students is palpable. And I can tell you that many of the faculty, who have gotten pulled into the game through one play mechanic or another, are feeling a real pride in their school for its willingness to embrace this kind of experimentation and innovation. (Jenkins, 2011)

## Environmental Game Design

“Environmental game design” is a new term proposed here to describe the practice of designing games with and around the lived environment of players so as to manifest an impact on the way in which that environment is used. This terminology is drawn from the domains of urban planning and architecture. David Mocarski, Chair of the Environmental Design program at the Art Center College of Design, describes environmental design as “a human-centered discipline that is focused on the design of a user’s total experience,” involving “spatial, object and emotional communication.” (Mocarski, 2012) Designers working in environmental design “plan, design, and implement systems . . . that are added to or overlaid onto and into existing or planned places and spaces” in order to enable “wayfinding,” “interpretation,” and “placemaking.” (Calori, 2007) Environmental game design is the application of game mechanics to these ends.

This terminology is chosen because it describes a very specific use case for games. However, I also choose the term, “environmental game” to describe Reality Ends Here in order to make a break from the conceptual baggage associated with terms like “alternate reality games,” “pervasive games,” “big games,” and “location-based games,” among others. These terms entered into the design consciousness during the first half of the first decade of the 21st century. In their initial formulations, they referred to relatively specific domains of design practice. However, as the decade wore on, the

boundaries between these domains became increasingly fuzzy, resulting in terminology with ambiguous and contested meanings.

For example, in its initial usage, the term “alternate reality game” referred to a very distinct kind of temporally-bounded puzzle- and event-driven interactive transmedia scavenger hunt. (See Watson, 2010) However, over the past several years, this term has increasingly been used to describe numerous other kinds of practice. Games such as *SFZero* (2006), *World Without Oil* (2007), and *Socks, Inc.* (2010), among many others (including *Reality Ends Here*), are routinely referred to as ARGs, even though their structure is fundamentally distinct from classically-structured ARGs such as *I Love Bees* (2004), *Year Zero* (2007), and *Flynn Lives* (2009). In spite of their sensitivity to the interests and competencies of active audiences, classically-structured ARGs are effectively “top-down” storytelling vehicles designed around a core activity of collective “search and analysis.” (McGonigal, 2007) In this sense, such ARGs are not actually games. Rather, they are a form of interactive participatory storytelling which generate player experience through the machinations of behind the scenes “puppet masters” rather than through the rules and procedures of game mechanics. Games like *Reality Ends Here* work in a completely different way, largely eschewing top-down storytelling and instead producing diffuse and improvisatory “bottom-up” narratives through media participation structured by genuine game mechanics. While the term “alternate reality game” may have a utility in short-handing the notion that a given game is “played in the real world” or “woven into the fabric of everyday life,” this utility is increasingly outweighed by the confusion it produces.

The simple fact that some ARGs are truly games, while others are not, when considered in light of the growing interest in using real-world play to bring about change in *this* reality rather than an “alternate” one, is more than enough reason to seek out a new and more capacious term of art. A common solution to this challenge is to describe a work as a “pervasive game.” Finnish researcher Markus Montola defines a pervasive game as “a game that has one or more salient features that expand the contractual magic circle of play socially, spatially or temporally.” (Montola, 2005) While this definition is sufficiently broad so as to include the range of interaction designs present in classically-structured ARGs and newer forms alike, the term itself is wanting. The adjective, “pervasive,” carries with it far too much specificity. Taken literally, a pervasive game would be a game that “exists in or spreads through every part of something.” It is impossible to imagine any game meeting the high bar of actually being “pervasive.”

Other terminology is similarly either too specific or too vague. “Location-based games” require “a link between locations in the physical world and game-play” and the use of “location-aware technologies, often mobile phones, as a means of localization and/or communication.” (Ejsing-Duun, 2011) Environmental games need not use any kind of digital technology, and nor are they necessarily linked to purely physical environments. Similarly, terms such as “big games” and “street games” evoke the urban play activities on view at festivals such as *Hide and Seek* or *Come Out and Play*, but fail to account for games that take place in other kinds of lived environments. “Ambient games” comes closer to being a satisfactory definition, but fails to evoke the active nature of play—an ambience is something that happens in the background, whereas a game requires agency. Finally, “environmental interaction design” might have a slightly friendlier ring to those who are put off by the notion of games, but the fact remains that games and interaction are distinct from one another: an iPhone is an interactive device, but it is not a game. We therefore propose the term, “environmental game” to describe the category of design practice to which *Reality Ends Here* belongs. Work produced in this category of practice is designed to address and leverage the conditions present within specific lived environments in order to bring about changes in those environments, and uses game mechanics to achieve this end.

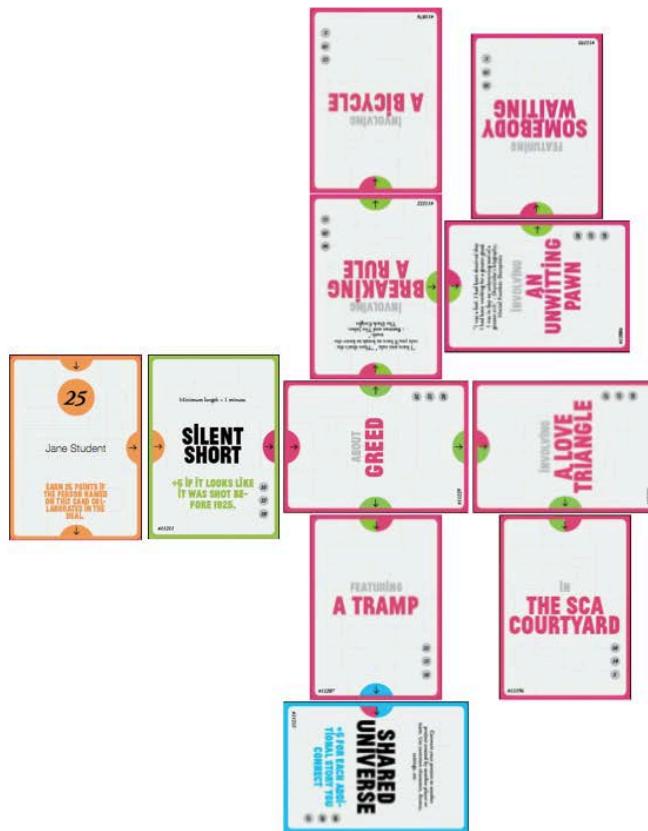
## A Procedural Creative Prompting System

*Reality Ends Here* is an environmental game driven by a card-based “procedural prompting system” (see Figure 2): by sharing, trading, and combining cards, players create challenges within the constraints of a connectivity play mechanic.

As designers, we decided from the start that it was important that the challenges in our game come from the players, not us. We felt that a set of challenges curated “from on high” would take away many crucial aspects of agency and authorship from our players—and since those things are at the heart of the kind of creative and performative impulses that underly engagement with our game, we decided that we needed to protect them.

On the other hand, we understood that a total lack of constraints could be hobbling to creativity, particularly for players who were not already ensconced in strong “maker” or DIY communities and practices. As Orson Welles famously said, “the enemy of art is the lack of limitations.” Brainstorming, story workshopping, or any kind of creative spitballing without clear constraints and anchors will often drift into outright confusion.

To address this issue, we devised a simple card game that structures and limits creative brainstorming in a manner similar to a Tarot deck. Through this card interaction, players generate creative prompts of varying complexity.

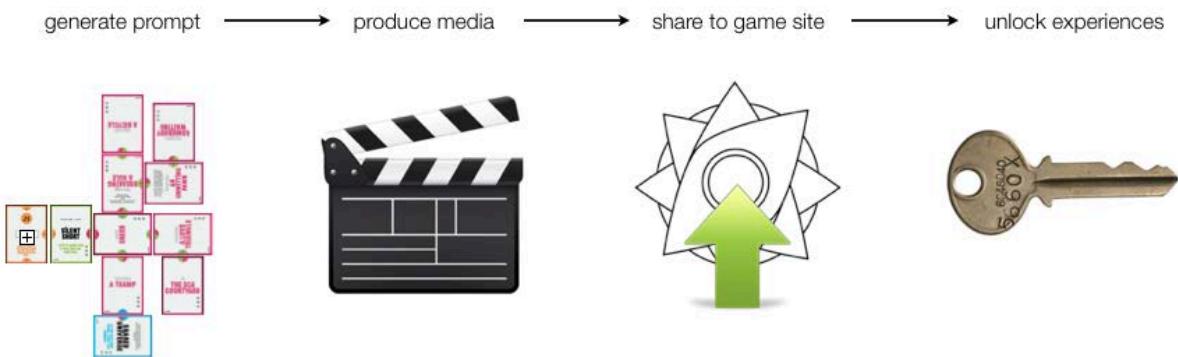


**Figure 2: Sample card combination. By connecting cards in this manner, players generate creative media-making prompts.**

In order to score points in the game system, players must respond to the creative prompts that they have created by producing media projects (or “Deals”) across a range of platforms. Depending on the cards used in the prompt, players may end up making films, staging plays, designing games, drawing and inking graphic novels, or making one of 49 other possible media artifacts. Once players complete a project, they submit their work through the game’s website, then “justify” it via webcam, explaining how they satisfied the conditions of the creative prompt created through the card game. All this material—including a clickable list of cards used in the Deal, the completed project, the justification video, and the list of those who collaborated on the project (including links to their profiles)—then appears live on the game site, sharable with the world. Readers of this document who wish to see the projects produced by players of *Reality Ends Here* may view the archive of completed Deals at <http://reality.usc.edu/deals/>.

Players may work with as many other players as they like, and may submit as many media artifacts as they can make. The more media artifacts they submit, the more points they will earn. Additional points can be earned by commenting on the work of other players, posting status updates, and sharing photos. By scoring points, players advance on a multi-category leaderboard and can earn access to special experiences and mentorship encounters related to media making and analysis.

Once underway, the game proceeds in weekly cycles, beginning on Sunday evenings. At the start of each week, the Weekly Leaderboard is reset. The top four players who earn the most points during a given week are declared the “Weekly Winners.” Weekly Winners receive special mentorship experiences involving offbeat and personal encounters with alumni working in various facets of the media industries. These encounters typically take place during the following week. This weekly points competition enables new players to join in and compete on a level playing field regardless of how long the game has been running for prior to their induction. In the absence of weekly point resets, early adopters of the game would gain an unfair points advantage over players who join in later phases, resulting in a sharp drop off in player induction in the mid-game and beyond.



**Figure 3: Schematic of complete play cycle.** Players generate prompts, produce media artifacts in response to these prompts, then share them to the game site. Based on the complexity of the projects they submit, players earn variable numbers of points in the game system. Crossing certain points thresholds unlocks special mentorship experiences.

### Offline collaboration, online performance, and built-in assessment

The game’s website also serves as a social networking platform for SCA students, faculty and alumni. All players have profiles on the site, which aggregate all their Deal-making activity and status updates, along with displaying any photos they have submitted to the site. Profiles also include an evolving data visualization that is generated based on the kinds of Deals and activities that the player has been involved in. This rich media environment aggregates into a database and constitutes a rich trove of at-a-glance assessment data for both faculty and for students keen on discovering new collaborators. This data is currently being analyzed by the design team and by outside researchers, including Benjamin Stokes of the Annenberg School of Communication at USC.

While most of the site is publicly viewable, including player profiles, some social networking functionality is semi-private, primarily because we wanted to create a kind of exclusive workshopping space—which we’ve named “The Bullpen” after a historic cinema school workshop space here at USC—where players can feel free to brainstorm, ramble, and even trash-talk “behind the curtain.” Other features not immediately visible to non-players include the Leaderboard, which tracks scores on a weekly and overall basis in a variety of dimensions, the Card Lookup feature, which players can use to view and discuss individual cards in the archive, and the Members Directory, which players can search by name or keyword when looking for collaborators or new connections. Further, many players have set up their own online discussion spaces to strategize their game activity, using platforms such as Facebook, Twitter, and Google.

### Informal, Optional, “Secret”: Activating Player Agency

The game is not mandatory for SCA students, nor is it openly publicized at the school. In fact, we went to lengths to keep it under the radar. The game is meant to belong to the players, not the other way around. Players discover it on their own, either through word of mouth or by picking up on clues left around the campus—clues hidden in old cameras, left near our mysterious flag which intermittently hangs off the third floor balcony, or hanging from LED throwies we’ve stuck to the underside of staircases. One by one or in groups, they come to the Game Office, undergo the initiation rites, receive their game cards and website logins, and start playing.

Why did we go to these lengths? After all, we have more or less complete control over our player population. They are students. We could tell them to do something and they would have to do it. That is how they expect their education to work. So why don't we just say to them: go learn about the other divisions of the school, form into interdisciplinary teams, and then make x number of creative projects? We have the power to give assignments and set deadlines. We could enforce our demands with grades. Why did we make all this extra work for ourselves?

Outside of an educational institution, we would not have the ability to "conscript" our player population. In the open market, the best we could hope for would be to capture a decent percentage of our potential players through savvy communications design and the creation of a genuinely engaging product. In this competitive context, the notion that one could simply compel all of a given target demographic to sign up and play is something that almost any design team would find difficult to resist. But in the end, the wise designer wouldn't give in to that hypothetical temptation — and for the very same reason that we didn't simply turn the game into an assignment. And that reason can be found in understanding what it is we mean when we say the word, *play*.

Here is a classic definition of play from Johann Huizinga's *Homo Ludens*:

Summing up the formal characteristic of play, we might call it a free activity standing quite consciously outside 'ordinary' life as being 'not serious' but at the same time absorbing the player intensely and utterly. It is an activity connected with no material interest, and no profit can be gained by it. It proceeds within its own proper boundaries of time and space according to fixed rules and in an orderly manner. It promotes the formation of social groupings that tend to surround themselves with secrecy and to stress the difference from the common world by disguise or other means. (Huizinga, 1955, p. 13)

One can take issue with much of Huizinga's definition. For example, the very nature of *Reality Ends Here* is that it is an environmental game, and does not proceed within the "proper boundaries" associated with familiar games such as board games or video games. Further, proponents of art games and impact games would doubtless bristle at Huizinga describing games as being "not serious." But despite these definitional shortcomings, there is one thing in Huizinga's definition that is fundamental to any notion of what play is, and that is that it is a *free activity*.

Think of the enormous amounts of energy people invest into genuine play activities. A ready example is that of the young *Pokémon* player, who will, entirely without supervision or deadlines or course readers, master massive volumes of information about the *Pokémon* universe, the rules of the game, and the kinds of strategy and tactics required to win. They will do this because the game is personal to them. It means something in their world. It has a social value on the playground and in the lunchroom. It is a structured space within which they can explore different kinds of identity, mastery, and leadership. It belongs to them. They have chosen it. They have "opted in."

When players opt in to a play experience, they bring with them the awesome power of their own agency. In the case of a game like *Pokémon*, players will yield up hundreds upon hundreds of hours of precious childhood playtime to master the game. That's the power of agency, and that's what engaging people in true play experiences can do.

Interaction designers know that they need to protect player agency at all costs. Within a given game system, this means thoughtfully designing play mechanics such that player action visibly and meaningfully shapes the evolving state of the game. If the game becomes random or deterministic, if it ends up feeling like everything is "on rails," or if the relationship between the players' choices in the game and the effects those choices have on the system is not apparent, players will cease to feel in command of the experience and will invest less of themselves into the game. And once a certain threshold is crossed, players will opt out entirely.

Crucially, player agency must also be protected in the context of the invitation to play the game in the first place. In most game design situations, this is something designers don't have to worry about, since games are typically conceived of from the start as something that players will only play if they feel like doing so. But in the realm of impact games, this isn't always the case. In education, for example, students are often "told" to play games in lieu of traditional assignments. Telling players to play in this manner is a sure-fire way to compromise their personal investment and sense of agency.

## Action, Not Simulation

Of course, personal investment and sense of agency are not always of prime importance in applied game design. The point here is not that educational games or other kinds of impact-oriented games should always be agency-rich opt-in experiences. Every design brief is different. In many instances, games can be effectively used purely as simulation tools, or as methods for constructing complex arguments or presentations that would be difficult or impossible to execute using other media forms. Students can be asked to interact with a simulation, and can genuinely learn something about the system that the simulation models, even if it's not something they would normally interact with of their own accord.

But our mandates are about action, not simulation. They are about what the players are *doing*, not what we are *showing* them. The objective of *Reality Ends Here* is to transform the environment at the SCA, not merely deliver information. We needed to create a play experience that would bring about the kinds of social and creative situations that the school had identified as being missing or under-represented. These situations couldn't just be one-offs. This was about effecting lasting change. It was about enlivening—and, in some senses, creating—a community. To make that happen, we would have to inspire sustained and deeply personal involvement in the game. That kind of passion isn't something you can tell people to have. They have to find it on their own. Students discover *Reality Ends Here* the same way they discover things like the college radio station. They hear about it, and if they like the sounds of it, they show up and pour their hearts into it.

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## **Workshops**



# Using Interactive Metaphors and Popular Game Designs for Science Education

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**Abstract:** This workshop will introduce attendees to a distinctive approach to building games to support middle-grades science learning. This IES-funded project is creating Nintendo DSi games that combine familiar casual game genres, high quality production and careful instructional design. The games are played by students prior to instruction as homework or during other non-instructional time, and stimulate students to develop shared, novel visualizations of abstract phenomenon. Teachers are then supported in using that common visualization as an anchor for analogical thinking about counter-intuitive scientific concepts that are often the subject of scientific misconceptions. Attendees will be introduced to the project approach, and invited to play one of the games, which uses a *Pokémon*-style battle paradigm to introduce concepts about randomness and dominance that are fundamental to understanding genetic heredity. The session will include time to provide feedback and discuss the game approach with the developers and designers of the games.

## Introduction

In recent years an increasing number of researchers and practitioners have embraced the notion that educational games can successfully support student learning. Examples of various approaches abound, from simple games that surround traditional “skill and drill” activities and can be used in one class period to complex immersive worlds that require weeks to implement. But many questions persist about how best to design and implement games that closely complement existing instruction and target particularly difficult topics. With the *Possible Worlds* project, we have attempted to develop innovative games with unique mechanics that utilize popular game genre conventions, integrate easily with traditional classroom practices, and target topics that teachers recognize as urgently in need of new instructional approaches.

*Possible Worlds* is a suite of digital games for the Nintendo DSi with accompanying classroom activities that are designed to help middle grade students master persistently difficult science concepts. The use model is based on “preparation for future learning” (Bransford & Schwartz, 1999), a pedagogical model in which students have an initial interaction with materials that they may not fully understand, but which prime them for later explanation from a teacher. In *Possible Worlds*, students play digital games outside of instructional time, as homework or during other non-instructional time in school. The games center on an instructional activity or interactive metaphor that teachers can draw upon during instruction to ground their explanation and help students conceptualize novel and counterintuitive phenomena.

Building on prior research on the development of scientific thinking (Kuhn, 2001), we theorize that part of the reason why naïve theories are so much more persuasive than counter-intuitive scientific theories, is that the scientific theory is much harder to imagine. They can be illustrated, but interpreting those illustrations often requires understanding the very process they are designed to illuminate. Providing students with an opportunity to construct a novel visual representation that has an analogical relationship to the complex concept at the heart of the misconception can help students make sense of new information about the target concept as they receive it. It may help them make sense of the scientific idea, provided it is followed by the teacher delivering the essential “tell,” identifying the significance of the illustration and linking it to the curriculum.

## Research Context

Two primary bodies of cognitive and developmental literature ground the development of the game modules. First, well-designed casual video games—that is, games that do not require players to invest long periods of time on game play and character development, or whose narrative developments are not strongly dependent on player game choices—can be effective tools for helping learners develop preconceptual mental models in targeted learning domains (Reese, 2007). Reese

argues that game-based instructional design informed by *structure mapping theory* (Gentner, 1983) can promote the development and practice of analogical reasoning by providing learners with opportunities to have game-based experiences analogous to those in the targeted learning domain. Thus, educational games whose features are designed to map to conceptual features in a target domain can become metaphors for abstract concepts learners will encounter in their school classes.

Our second major point of reference is the idea that if students are to capitalize on games as “metaphor primers,” teachers must provide them with the scaffolding and guidance they might require to make connections between game play and targeted learning concepts. Bransford and Schwartz’s (1999) “preparation for future learning” (PFL) model effectively frames our thinking—educational interventions are followed by a form of direct instruction, which should increase the likelihood of transfer. In the PFL framework, activities “set the stage” for learning with direct instruction by providing students with experiences from which they can draw to make sense of subsequent material. In *Possible Worlds*, games are designed as analogs to abstract, scientific concepts, furnishing teachers and learners with experiences they can draw upon to frame and make sense of challenging concepts.

The PFL model does not adequately account for the quality of the direct instruction, however. That is, in order to increase the likelihood that learners make connections between the game as a metaphor and the targeted concepts, teachers will have to be prepared to help their students by clarifying features the two share and by discussing how the processes in both are alike (Cameron, 2002; Venville, 2008). Beyond the game, the additional materials we have developed are designed to assist teachers in helping students to make those connections. In addition to clarifying common features between metaphor and concepts, dynamic assessment methods such as “graduated prompting,” which probe learners’ understanding with a range of increasingly explicit prompts about the concepts, will also be used to promote student reflection and analogous reasoning (Bransford, Brown, & Cocking, 1999; Campione & Brown, 1987; Lidz, 1997).

### **Supporting teachers, not replacing them**

Because our games do not carry the burden of teaching—of delivering accurate information or explanations of concepts—students are not expected to walk away from playing these digital games with a sense of how the visualization embedded in them relate to anything they encounter in their science class. They understand the visualization only within the context of the game.

We provide teachers with a range of support materials that constitute a bridge between the digital game play at home and the lesson in the classroom. We provide them with images and interactive puzzle activities they can project during lectures and discussions, and extension activities that use the visualization as an illustration of a scientific concept.

We also provide teachers with a consolidation activity, which does not require any technology, but supplies a guided way to help students align evidence with claims in complex non-fiction texts. The key concepts in this consolidation game-like classroom activity focus on the particular misconception we are trying to address.

These materials are designed to be used in a specific sequence, to support students in acquiring, extending, and applying new conceptual knowledge. But we deliberately ensure that each resource can also stand on its own, making clear that teachers could use any or all of them by “dropping” them into their curricula.

### **Using diverse expertise**

While there are project members at CCT with game design experience, from the inception of the *Possible Worlds* project we knew we wanted to work with a dedicated game development company. 1<sup>st</sup> Playable is a commercial game shop with a proven track record of delivering successful games for the Nintendo DS. They also have a strong interest in educational games, hosting the Educational Games Symposium annually to help local educators become familiar with the potential for games in the classroom.

Partnering with 1<sup>st</sup> Playable has allowed us to divide up the game development process in a way that we believe builds on each partners’ unique strengths. At CCT, our content experts and child development experts collaborate to define the educational goals of each game and decide on the core

interactive metaphor with which players will engage. Then, throughout the game development process, our researchers work with students in afterschool programs and in classrooms to test game prototypes, ensuring that design decisions support the intended thinking.

Meanwhile, 1<sup>st</sup> Playable focuses on the larger design of the game including the game mechanics that will incorporate and surround our instructional activity. They also have skilled artists and designers who create the game's narrative, art, music, and level design. Their involvement ensures that the games feel like "real" games to kids, and offer familiar, fun, genre-based challenges that encourage students to play for sustained periods, extending their exposure to the core instructional experience.

Weekly meetings ensure that their game design efforts remain in line with the game's instructional goals, including age and gender appropriateness. At times, their suggestions to improve the fun of a game can conflict with or undermine the core metaphor, and at these points negotiations between organizations ensure that the games remain as enjoyable as possible, while being tightly focused on the key instructional idea. At other points, the educational value of a game may be firmly established, and 1<sup>st</sup> Playable is able to freely add to the game to improve playability.

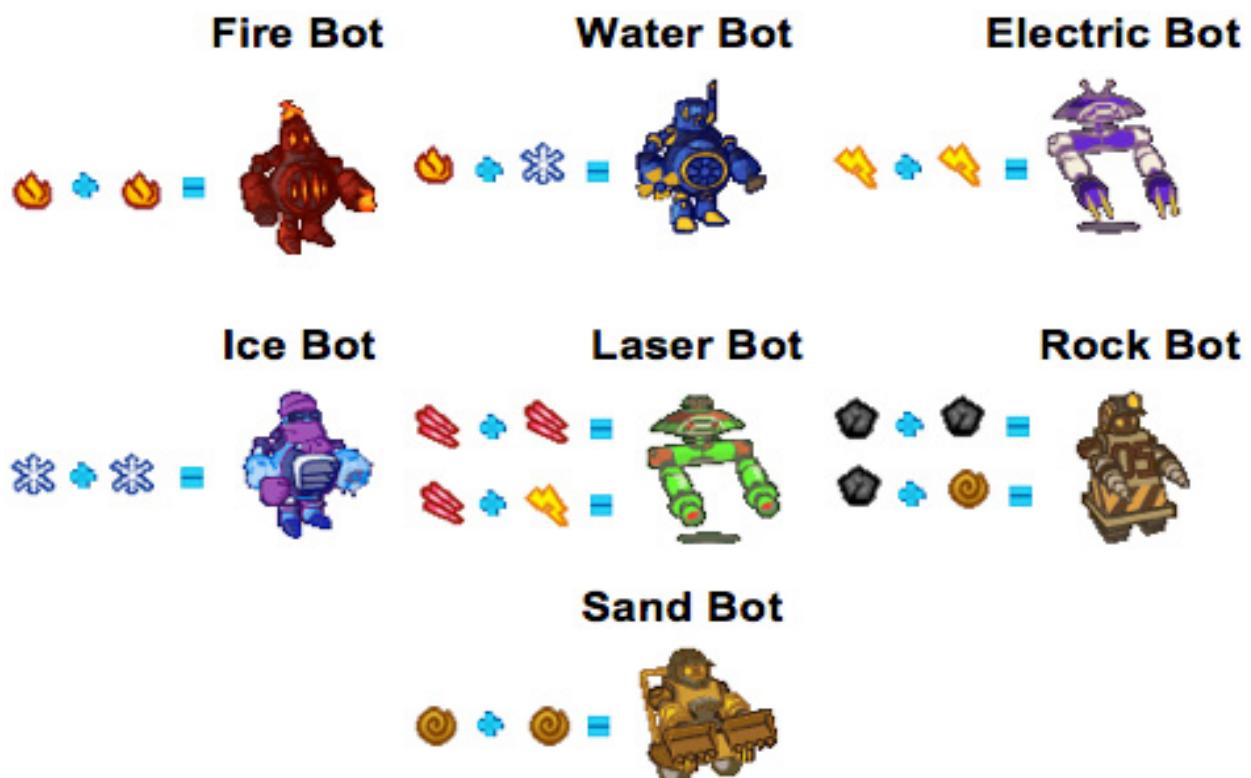
### **Module 2: RoboGen**

*RoboGen* is the second game in the *Possible Worlds* series and is designed to address two misconceptions in seventh graders' understanding of genetics. These have to do with the random nature of genetic inheritance and the genetic meaning of dominance.

The game is set in the world of Azalan where people depend on robots to do many tasks for them. As the story begins, many robots have become infected with a mysterious virus and have begun to behave in unpredictable and destructive ways. The player's character is a member of the Robot Rescue Squad and is charged with the task of repairing the infected robots. To do that, the player must use his or her own team of robots to disable the infected ones and install an anti-virus program.

There are a variety of different environments in Azalan, and in each place the robots have different "traits" that relate to the function the robot serves. For example, Rock Bots and Sand Bots are initially encountered at construction sites and do construction work, Ice Bots work in skating rinks, etc. Each type of robot is powerful against some types of robots, and weak against others. To win the game, players must create teams of robots with traits that match well against the weaknesses of the infected robots in a particular encounter.

If the player chooses the correct robots, his or her team will be able to disable the infected robots and the player can install the anti-virus software. The player does not start with a robot team, however. Instead, he or she must visit the Recycler and combine two broken robots to create one functional robot. Each robot's type is determined by two parts (analogues to allele pairs in genetics) that can either have complete dominance, or co-dominance. For example, Rock Bot can have two rock parts or one rock part and one sand part, while a Fire Bot must have two fire parts, an Ice Bot must have two ice parts, and a Water Bot has one fire and one ice part (see Figure 1).



**Figure 1: To Robot Parts**

In the Recycler, the player combines two robots, attempting to create one that will be successful against a specific infected robot. Which of the two robots' four parts that will combine is random, however. Thus, a player may combine two Water Bots to produce an Ice Bot, but a Fire Bot or another Water Bot, could also result. It may take multiple tries to produce the desired robot.

#### The science within the game

We used robots rather than biological creatures in this game because we wanted to avoid exacerbating already prevalent confusions among adolescents (and many adults) about hereditary traits and evolution. Many seventh grade students are confused about what an "evolutionary advantage" is. Instead of understanding that it means survival until procreation makes it possible to pass the trait along to the next generation, many students think it means having a characteristic that allows one to succeed in an environment. By using robots, which do not mate, have no life span, and exist to fulfill a single function, we sidestep those misconceptions.

Most seventh graders have a partial and concrete understanding of the word "random", understanding it as meaning "no pattern," "by chance," "arbitrary," or "unpredictable." However, they have a very hard time understanding that if a series of possible events is randomly generated, the next event has no relationship to the event that preceded it and will have no effect on what happens afterward. The notion that each event is *independent* even though there is an over-all distribution or pattern is deeply counter-intuitive.

The idea behind the Recycler in RoboGen is to help students visualize the randomness in heredity. They can watch how the random selection of one part (allele) happens within both "parents" and how the resulting robot is always a combination of the two parts. Randomness is in play, because sometimes it takes many attempts to get the combination that produces the robot the player wants for strategic reasons. The desire to get the right robots to win each encounter focuses the player's attention on the random nature of robot heredity, but without a teacher making the analogy to randomness in general, and biological heredity specifically, few kids would make any connection between the game mechanic and the material covered during class.

Dominance is another difficult aspect of genetics. Many seventh graders harbor a common misconception that dominant genes are stronger and better or carry traits that facilitate survival, while

recessive traits are weaker and less useful. They may recognize that brown eyes are not really superior to blue eyes, but when it comes to other traits, the misconception that "dominant" means "more powerful" easily reasserts itself.

In this game, each robot has a single trait (*ice, water, fire, rock, sand, laser* or *electric*), which determines its phenotype. The central game mechanic asks players to consider how this trait empowers the robot in relation to other robots,.. and dominance is clearly unrelated to power. In the Recycler, the rock part, for example, is dominant over the sand part, but when they meet, Sand Bots are stronger than Rock Bots. On the other hand, the laser part is dominant over the electric part, and Laser Bots are stronger than Electro Bots. Fire parts and ice parts are co-dominant, but Fire Bots are stronger than Ice Bots, and Water Bots, their "offspring," are stronger than Fire Bots and weaker than Ice Bots.

### Demonstrating our approach and its result

For the Games+Learning+Society Conference, we would like to lead a workshop where participants play *RoboGen* and discuss its pedagogical approach and its development process. 1<sup>st</sup> Playable's founder and *RoboGen*'s Production Lead Tobi Saulnier and CCT's Production Manager John Parris will facilitate a discussion with participants about how perspectives on child development, content information, and game design were balanced throughout the game development process, and how teachers and students responded to the game during an April 2012 field test. For the workshop, we would supply 16 Nintendo DS's and game cartridges.

The workshop would begin with a brief presentation on the pedagogical ideas that underlie *Possible Worlds*, and the status of the project. We would then introduce *RoboGen*, and provide brief game play instructions. DS's would be distributed, and for the next half hour, participants would have the opportunity to play the game. Tobi and John would circulate, answering any questions while participants played and ensuring that they never became stymied by the game's challenges. Debugging cheats built into the game would allow participants to experience the game's higher levels without requiring the normal play time of several hours. After playing the game, John and Tobi would make concluding points before participants were invited to ask any additional questions and respond to the approach taken by the *Possible Worlds* project.

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## WORKSHOP

### ***I Made That: Game Design Across the Curriculum***

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**Abstract:** Digital game design is emerging as an effective way to engage students in research, creative development, and collaborative project-based learning activities. The Learning Games Network, a non-profit spin-off of the MIT Education Arcade, and FableVision, a transmedia storytelling company, have developed the *Game Design Tool Kit*, a set of tools to support teachers as they integrate design activities into their teaching. Focusing on iterative design and development strategies that help teams of collaborators move from a "big idea" to functional documentation and focused "pitch materials," the *Game Design Tool Kit* is currently deployed with partners at the Kentucky Student Technology Leadership Program and John Lennon Educational Tour Bus and is emerging as an effective set of resources to engage students in learning across a variety of subjects. This hands-on workshop will take participants through a condensed design development and documentation process.

#### **Workshop Format**

During this workshop, we will divide participants into small teams that will explore a pre-selected group of interdisciplinary topics. Teams will work with the *Game Design Tool Kit* to develop a preliminary learning game concept. Although workshop time is limited, we will preview all stages of the *Game Design Tool Kit* methodology to give participants a solid context of how it can be integrated into the curriculum or used in lieu of other project-based learning activities.

#### ***Explore-Discover-Create-Share***

The *Tool Kit* emerges from our collaborations with researchers, publishers, and a wide range of media partners to develop learning games. The first elements of the framework were developed by Henry Jenkins, Sande Scoredos, and Alex Chisholm for a workshop on "Adapting Linear Storytelling in an Interactive Age" first held during MIT's Independent Activities Period in January 2000. Over the past decade, the workshop was refined and extended across other activities, including a large-scale deployment in the State of Kentucky as part of an HP Catalyst project and a variety of "Game Design Boot Camps" organized with FableVision. With an emphasis on iterative development, resources are segmented into four phases:

<b>Explore</b>	Early phase of development to establish common vocabulary around games and start the research process
<b>Discover</b>	Brainstorming, creative development, and early documentation
<b>Create</b>	Paper prototype and sample art/audio asset development
<b>Share</b>	Play tests and concept "pitch"

Within each phase, we encourage teachers to emphasize the concepts of ***Explore-Discover-Create-Share*** as sub-cycles, reminding students to continually exercise their research and creative design skills as they develop and test their game concept.

The workshop will walk participants through elements of the **Explore** and **Discover** phases of development while presenting hooks to additional phases and, ultimately, technical implementation using tools like *GameSalad*, *GameStar Mechanic*, *Scratch*, and *GameMaker*.

#### **Game Design Tool Kit Details**

The *Tool Kit* starts with a stack of index cards that are labeled for each phase and step of the design process. Online videos, lesson plans, and bulletin boards developed by the Learning Games Network and FableVision support teachers and enable them to share best practices as they integrate game design into instruction.

This current version of the *Tool Kit* focuses exclusively on the *creative concept development* process. Technical implementation of the concept (*i.e.*, digital prototyping and game programming) will be included in later versions of the *Tool Kit*.

The project-based methodology and online components are designed to support teachers who aim to coach and collaborate with their students through the game design process.

While the *Tool Kit* emphasizes working with students to create *learning game* concepts that support topics central to the curriculum, it can also be used for a much broader set of games.

The *Tool Kit* may be used as part of formal instruction as an alternative to other research, writing, and project-based activities in middle and high school (Grades 7-12) that encourage students to explore subjects and topics across the curriculum or as a framework to guide extra-curricular club activities.

Depending on schedule and pace, we recommend teachers consider using the *Tool Kit* over several weeks (2-3 minimally) or over the course of a 10-week school quarter (recommended implementation). This will give students an opportunity to spend time researching, creatively designing, testing, and iterating their work.

All resources are available online. Index card labels, available as downloadable PDFs, have been formatted for easy printing on Avery labels. Videos can be streamed, while PDFs of lesson plans and evaluation rubrics can be downloaded and printed for classroom or club use.

## Components

A complete list of Game Design Tool Kit components follows:

- (1)   **Video: *Introduction to the Game Design Tool Kit***  
**Guide:** Getting Started
- (2)   **Video: *EXPLORE: Creativity and Play***  
**Lesson Plan:** Exploring Game Genres
- (3)   **Video: *EXPLORE: Question and Research***  
**Lesson Plan:** Sparking Playful Research
- (4)   **Video: *DISCOVER: Design It***  
**Lesson Plan:** Brainstorming with Young Designers
- (5)   **Video: *CREATE: Prototype***  
**Lesson Plan:** Getting Ready to Prototype
- (6)   **Video: *CREATE: Play Test***  
**Lesson Plan:** Preparing to Play Test
- (7)   **Video: *SHARE: Write and Pitch***  
**Guide:** Evaluating Student Work
- (8)   **Video: *SHARE: Tools for Making a Pitch***  
**Guide:** Tools Young Designers Can Use

The GLS workshop will walk participants through the *You Be the Judge*, *Creating Sparks*, and *Design It!* lessons.

# **Studio K: A Game Design Curriculum for Computational Thinking**

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**Abstract:** The Studio K curriculum is designed to engage students in habits of mind germane to game design, as well as computational thinking. Utilizing Microsoft *Kodu*, students are encouraged to reflect on their own gaming experiences to decompose and analyze the reasons why games are fun, and then transfer those patterns to their own games. Given the increasing demand by companies, governments, and society for people who know how to think computationally (i.e. think critically, logically, and solve problems in innovative ways using computational tools), in order to be competitive in the knowledge economy (Wing, 2006; National Academy of Sciences, 2010), the Studio K curriculum uses the potential of game design to prepare youth with skills germane to computational thinking, and the so-called STEM disciplines whose practices heavily rest on computation (Games, 2010; Hayes and Games, 2008). This potential has been recognized by the White House's efforts (White House, 2009) to support educational video game design, including national game design contests and supporting programs that teach computational thinking.

## **General Notes**

This workshop will give participants hands-on experience with *Kodu* and a framework for incorporating the curriculum into their classrooms or other learning spaces. Computers and game controllers (optional) will be provided.

## **Introduction**

Thirty years ago, learning to “program” was bracketed off as something specialized for uncool nerds or computer scientists. But as digital devices become integrated into every aspect of our lives, it is imperative that people become literate with digital technologies. This requires more than knowing how to use an operating system or applications—or even how to program—but rather how to abstract from situations and think algorithmically (Wing, 2006). Indeed, computational thinking is essential for success in the modern world as the digital revolution transforms professional practices—even the structure of entire industries—and citizens must understand some computation to participate in modern life. 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 use computation to reach their own goals.

In that sense, computational thinking is defined as the ability to use computation to understand new content, synthesize it, and use it. Classic examples of computational thinking use computation to improve students' abilities in math or science class. A broader view suggests that computational thinking skills can help students read the paper, do their taxes, or participate in political life. The real power of computational thinking, however, 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 describes an ability to answer “What can I build to understand this problem?”.

There are several paths to acquiring those abilities, most of which involve learning to program and learning to communicate with the logic of programming. While not everyone needs to understand the finer points of red-black trees, almost everyone would benefit from understanding how to create and communicate with computation. However, there is very little instruction in the US that teaches students how to cross-apply computational thinking. Computer science is rarely taught in high schools, and, when it is, it is taught in an disconnected way that misses the point.

Tools like *Kodu* can revolutionize education by building on the successes of precursors like *Logo*, the programming language commonly used in education, but also by employing social gaming structures (badges, achievements, collaborative problem solving, etc.) to deepen participation and encourage players to become game *designers* (Games, 2010). Becoming a game designer means going beyond

technical creation to craft aesthetics, interactions, and stories that motivate users to play, and embedding Kodu in a larger social context would allow it to help children to learn to program socially and authentically.

In this workshop, we outline Studio K, an experimental club for teaching students *Kodu*, and *Studio K*, a social network designed to optimize and support learning complex computational content with *Kodu*. The Studio K curriculum is built on a complementary foundation of game design and computational thinking frameworks.

## Computational Thinking Framework

Computational thinking is a way of thinking and solving problems effectively using the logical, mathematical, and representational tools that computers make available work our way through data, and transform it into actionable information. Over the years, multiple frameworks of computational thinking have been proposed by scholars, that emphasize different aspects of the construct from the more abstract and logical operations necessary to construct a software algorithm, to the more social aspects involved in solving a complex computational problem collaboratively (National Academy of Science, 2010).

In order to operationalize the construct for this study, we rely on a framework recently proposed by [Google \(2010\)](#), which synthesizes most of these perspectives according to the actual practices of software professionals today. The framework characterizes CT according to five distinct dimensions that encompass habits of mind and practice germane to solving problems using computational tools. These are:

- **Decomposition** is the breaking down, or ability to break down, a problem into its core components. Identifying the core components of a problem often leads to Pattern Recognition and Generalization, which aids in Algorithm Design.
- **Pattern Recognition** is the ability to see or identify recurring themes. With regards to CT, this specifically means that users/students/programmers/etc. can identify these recurring themes outside of the problems that they encounter, which will aid them in applying these patterns to their current problem (see: Pattern Generalization and Abstraction).
- **Pattern Generalization and Abstraction** is the ability to recall previously encountered patterns and use them to aid in the solving of problems of a similar pattern. Although all of the dimensions that Google defines here are important, *abstraction* is a critically important concept in CT due to its cross-field presence and its role in the foundations of some of the most important concepts that we as humans use. For example, not only is abstraction the basis for algebra, but it is also the foundation for language and the way that we interpret and organize the world around us.
- **Algorithm Design** is the construction of a step-by-step process that will allow the user to solve the problem. For example, if someone were trying to navigate a maze, there may be only one solution, in which case an algorithm can be written for the player so that when followed, subsequent players will find the end of the maze, or the goal. It may look something like this:
  - Turn north
  - Move 1 step
  - Turn south
  - Move 2 steps
  - Turn north
  - Move 2 steps
  - Turn west
  - Move 4 steps

Additionally, using this algorithm, one can reliably recreate this maze, albeit the maze can take on a huge or infinite number of forms, so long as *one* of the solutions follows this algorithm. And while there may exist multiple paths to a correct solution for any given problem, some paths are also *more efficient* than others, which allows for this dimension to be evaluated at increasing levels of sophistication.

- **Data Analysis, Modeling, and Visualization** is the process by which we consume information and transform it into a meaningful form (input to output). A prime example of this is the reporting of statistical trends. Many people struggle with making meaning out of long sentences of numbers and data, so the presentations of those data are often visualized as

charts and graphs, and more abstractly, symbols and icons. These visualizations often carry much more meaning to viewers/listeners/consumers, and are thus more effective ways of communicating messages and information.

We chose these five dimensions given that they present two advantages over those presented in other frameworks: 1) They are measurable, meaning that there are concrete and perceptible processes and products that can be captured by systematic research either through observation or other means. 2) They are applicable to a broad range of professions and activities involving the use of modern computing tools, which in our view is a necessary prerequisite to differentiate computational thinking from other forms of logical and mathematical abstract thought.

## Game Design Framework

The Game Design Framework that we use for the Studio K curriculum actually consists of two frameworks, one involves breaking down games, as a medium, into their core components, and the other is the process by which students are allowed to bring in their own gaming experiences.

### *Dimensions of Games:*

- **Goals:** Goals are the objectives of the game. They tell the player what to do, where to go, and how to win the game. By changing the goals in the game, a game designer can change how the players navigate and interact with the game world.
- **Rules:** Rules define how players may behave within a system. In games there are consequences for breaking rules, such as lower score or the death of the player character.
- **Assets:** Assets are all of the physical things that make up the game world itself. The landscape, the buildings, the power-ups, and everything else that the player can see and interact with in the game are the assets. The design of the assets can impact the “atmosphere” and “feel” of the game.
- **Spaces:** Spaces are where the game takes place. By using different types of spaces, like tight and cramped or open and spacious, game designers can affect the kinds of experiences players can have.
- **Play Mechanics:** Play Mechanics are the things that players do in games. They are action words like “run” or “jump”. Giving access to or restricting the abilities or mechanics of players can change the extent to which players are able to interact with the game. This has an impact on how they are able to achieve the goals of the game, or win the game.
- **Scoring Systems:** Even though scores are not present in every game, they can have a large impact on player behavior when they are present. Scores can also be goals in games.
- **Narrative:** The narrative of a game provides the context for the players’ actions. It can also provide motivation for players to continue playing or quit.

### *Play, Fix, Create*

- **Play:** In the first step, students play a game that highlights one of the seven above-mentioned dimensions. The goal is for them to think about how that goal influenced their play experience.
- **Fix:** The students are then presented with a similar, but broken game. Their task is to identify what is broken in the game and then fix the problem.
- **Create:** The students are then allowed to create their own games, keeping in mind the themes of the lesson (Goals, Rules, etc.). However, because starting a game from scratch can be a daunting task, the students are given design scenarios or constraints.

By thinking of games through this framework, students are able to bring in their own gaming experiences and translate those experiences into *Kodu*. In turn, students learn how to think of games as systems, break down those systems into simpler patterns, and then reapply those patterns to new languages and representations.

## Studio K

Although only a pilot program, Studio K has thus far been successful in helping students develop ways of thinking about game design that will allow them to transfer their own gaming experiences into

Kodu. This workshop will give participants a chance to walk through *Kodu* and the Studio K curriculum and determine how it may fit into their own learning spaces.

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# **Newton's Playground: How to use evidence centered design (ECD) to develop game-based assessment**

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**Abstract:** Good video games tend to elicit numerous behaviors that can be used as the basis for enormous amounts of data that can be used to inform competency states. This begs the question of how video games can be used as assessment tools. In this workshop, we will present an implementation of a game-based assessment in the video game *Newton's Playground*. As part of the activity, participants of the workshop will create problems that assess the competency of persistence.

## **Introduction**

The main claim of researchers in the field of games and learning is that video games can facilitate learning because games provide a rich, engaging context that is conducive for learning to occur (Gee, 2003; Shaffer, Squire, Halverson, & Gee, 2005). Additionally, video games have many affordances for assessment (Gee & Shaffer, 2010; Shute, Ventura, Kim, & Wang, in press). Nevertheless, the notion of game-based assessment is still fairly new to the field of learning and assessment. To move forward with the idea of game-based assessment, we first need to understand how to marry the science of assessment development and the art of game design. Some of the questions that one needs to answer in the process of developing game-based assessment include: What does the traditional sense of item difficulty mean in a game-based assessment? How should difficult “items” in a game-based assessment look like? How should game designers develop in-game problems with varying difficulty? A powerful framework that can be used to tie game and assessment design principles together is evidence-centered design (Mislevy, Steinberg, & Almond, 2003). Evidence-centered design (ECD) has been the most pervasive assessment framework for game and simulation-based assessment, and has been used to develop multiple assessment systems (e.g., SimScientists, Cisco Packet Tracer). ECD offers a systematic approach to coherently aligning tasks or missions of the game that elicit evidence for the competencies of interest.

The proposed workshop aims to (a) review how ECD can be used as a framework that bridges game and assessment design principles, (b) re-think psychometric features of assessment (e.g., item difficulty) in the context of games, and (c) provide an opportunity for participants to create game-based assessments to measure persistence.

## **Evidence-Centered Design (ECD) for Game-Based Assessment**

The primary purpose of an assessment is to collect information that will enable the assessor to make inferences about learners' competency states—what they know, believe, can do, and to what degree (Shute, 2009). ECD defines a framework that consists of three main theoretical models—competency, evidence, and task models that work in concert (Mislevy & Haertel, 2006; Mislevy, Steinberg, & Almond, 2003). When the ECD framework is coupled with the game design process, it allows game designers and assessors to (a) decide and define the claims to be made about learners' skills, knowledge, and other attributes, (b) identify what behaviors in the game constitute evidence of the claim, and (c) determine the nature and form of problems in the game that will elicit that evidence. Therefore, a good game-based assessment elicits behavior that bears evidence about key competencies, and it must also provide principled interpretations of that evidence in terms that suit the purpose of the assessment. The following section describes three primary models of ECD (i.e., competency, evidence, and task models), and their roles in designing game-based assessments.

### Competency Model

A competency model (CM) is a structure of knowledge, skills, and other attributes to be assessed. Although ECD can work with a single variable CM, its strength resides in more complex multidimensional assessment, which is often the case in game-based assessment. Variables in the CM describe the set of knowledge and skills on which inferences are based (Almond & Mislevy, 1999). In game-based assessment, game designers and subject-matter experts need to determine, at the very early stage of the design, what skills and knowledge the game requires for players, and how those can be structured in a meaningful way. Some of the guiding questions to build a CM include:

“What kinds of skills do we want players to use to solve problems in the game?” “What attributes (e.g., persistence, curiosity) are relevant for players to succeed in the game”? Such questions are also commonly asked in game design processes.

#### Evidence Model

An evidence model (EM) expresses how the student's interactions with, and responses to, a given problem constitute evidence about CM variables. Also, an EM specifies what behaviors or performances should reveal those competencies. The EM indicates mathematical relationships between those behaviors and the CM variable(s). The task of specifying EMs is compatible with setting up rules of play in game design. Game designers often ask, “What do players need to do to move to a next level, and what counts as evidence to what extent?” Game and assessment designers need to ask such questions to construct EMs in game-based assessment.

#### Task Model

A task model (TM) describes what tasks or problems should be used to elicit behaviors defined in the evidence model. TM variables describe features of situations and tasks that will be used to elicit performance. A TM provides a framework for characterizing or constructing situations with which a student will interact to provide evidence about targeted aspects of competencies. The main purpose of tasks or problems is to elicit evidence (observable) about competencies (unobservable). In game-based assessment, TMs specify what players are expected to do and the features of problems or missions in the game environments with which players interact.

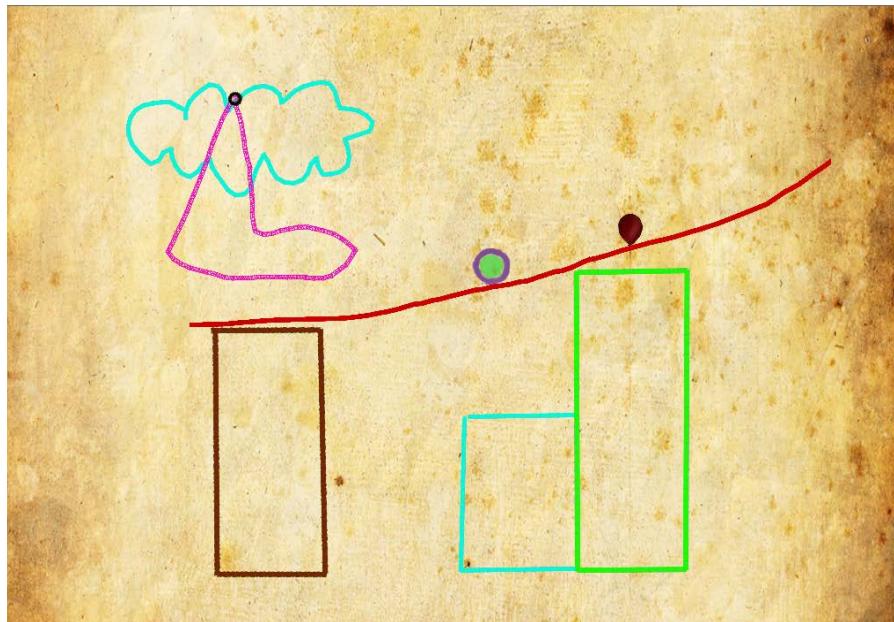
## **Stealth assessments in Newton's Playground**

### **Stealth Assessment**

Stealth assessment refers to ECD-based assessments that are woven directly and invisibly into the fabric of the learning environment (Shute, 2011). During game play, students naturally produce rich sequences of actions while performing complex tasks, drawing on the very skills or competencies that we want to assess (e.g., creativity, physics understanding). Evidence needed to assess the skills is thus provided by the players' interactions with the game itself (i.e., the processes of play).

### **Newton's Playground**

In this workshop, we will share some examples from our development project of stealth assessments in a physics game called *Newton's Playground* (NP). NP is a computer game that emphasizes two-dimensional physics simulations, including gravity, mass, kinetic energy, and conservation of momentum. The goal of each problem in NP is to guide a green ball from a predetermined starting point to a balloon. Everything in the game obeys the basic rules of physics relating to gravity and Newton's three laws of motion. The primary way to move the ball is by drawing physical objects on the screen that "come to life" once the object is drawn. For example, in the "golf problem" as shown in Figure 1, the player must draw an object similar to a golf club to make it swing and hit the ball. Also, the player needs to draw a ramp-like device to direct the ball to the balloon. The speed of the swinging golf club is dependent on the size and mass of the club drawn and the angle from which the player drops it to swing. The ball will then fly at a certain speed, length, and trajectory. We want to point out that NP is inspired by a popular physics game called *Crayon Physics Deluxe*. In fact, NP has the identical core game mechanics with *Crayon Physics Deluxe* (i.e., drawing physical objects to create forces in a 2D environment). Our motivation to develop NP was to enable us to incorporate assessment mechanics seamlessly into the game environment



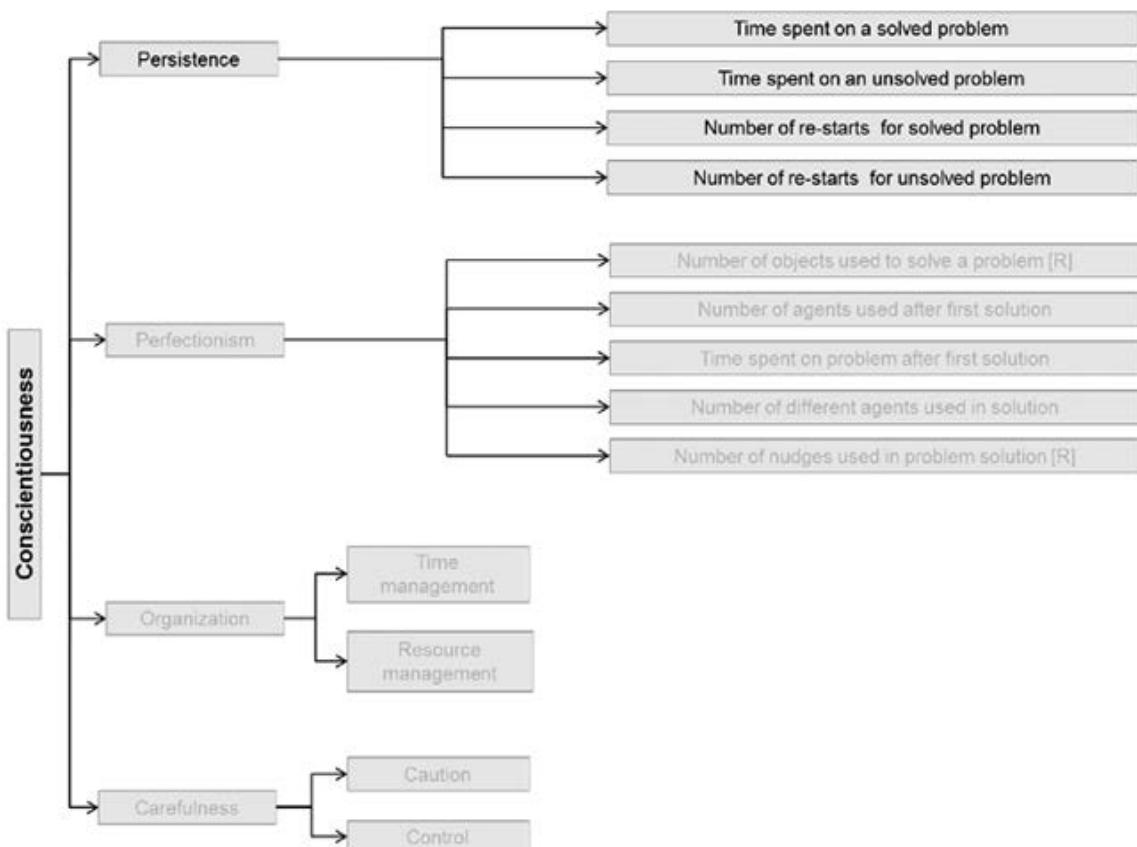
**Figure 1: The Golf Problem**

Various problems in NP require the player to create devices such as levers, pendulums, and so forth to reach the ball to the balloon. Thus all solutions provided by the player can be categorized based on *agents of motion*—physical objects that generate a force or change the magnitude or direction of a force. The following is agents of motion that are used in the game and relevant physics principles:

1. *Ramp*: A ramp can be employed to change the direction of the motion of the ball (or another object). In some cases, other devices (like a pendulum or nudge), are needed to get the ball to start moving.
2. *Lever*: A seesaw or lever involves net torque. A lever rotates around a fixed point usually called a fulcrum or pivot point. An object residing on a lever gains potential energy as it is raised.
3. *Pendulum*: A swinging pendulum directs an impulse tangent to its direction of motion. The idealized pendulum is a specialized case of the physical pendulum for which the mass distribution helps determine the frequency. One can draw a physical pendulum in NP, and the motion will be determined by the mass distribution.
4. *Springboard*: A springboard (or diving board) stores elastic potential energy provided by a falling weight. Elastic potential energy becomes kinetic as the weight is released.
5. *Pin*: A pin allows the position of one body to be fixed in space. Like a nail, it supplies a force large enough to resist motion of the point it is attached to. Two pins hold a body immobile against a background.
6. *Rope*: Ropes generally transmit tension between objects. Ropes can also act like trampolines, generating forces on objects by stretching the rope and then removing the force (by deleting objects) to produce upward momentum on the ball.
7. *Nudge*: An arrow in NP allows the player to gently nudge an object into motion.

### Assessment Development

We identified three core competencies that can be assessed in NP: conscientiousness, creativity, and conceptual physics understanding. Conscientiousness (C) is a multi-faceted competency that commonly includes tendencies related to being attentive, hard-working, careful, detail-minded, reliable, organized, productive, and persistent (Noffle & Robins, 2007). Meta-analyses have linked conscientiousness with grades between  $r = .21$  and  $.27$ , and the relationship is independent of intelligence (e.g., Noffle & Robins, 2007, Proporat, 2009). In this workshop we will focus on building tasks that will elicit behaviors (i.e., indicators) for one facet of conscientiousness, persistence. Persistence can be simply defined as willingness to work hard in spite of difficulty. Figure 2 displays the CM of conscientiousness as it is applied to NP. As can be seen, the facet persistence is highlighted and linked to behavioral indicators in NP gameplay.



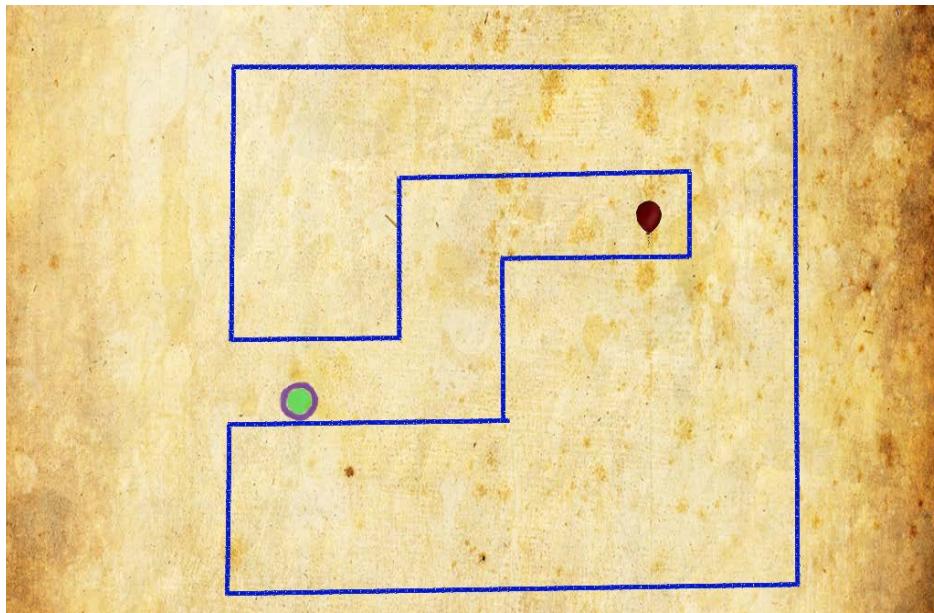
**Figure 2: A competency model of conscientiousness in Newton's Playground**

One of the challenges we are facing is figuring out how to ensure selected and created problems in the game are suitable for eliciting evidence for our three focal competencies. For example, assessing persistence is primarily based on seeing how long players spend or persist on difficult problems. Therefore, a good problem to assess persistence needs to have a “right level of difficulty” where the majority of players find it difficult yet interesting.

To address this issue we created difficulty rubrics for problems in order to systematically manipulate problem difficulty. This allows us to incrementally increase the difficulty of problems to ensure that students will eventually get to problems they will have trouble solving. Difficulty rubrics include:

1. *Relative location of ball to balloon.* If the balloon is positioned above the ball in a problem, this forces the player to use a lever, springboard, or pendulum to solve the problem (0-1 point).
2. *Obstacles.* This refers to the pathway between the ball and balloon. If the pathway is obstructed, this requires the player to project the ball in a very specific trajectory to obtain the balloon (0-2 points).
3. *Distinct agents of motion.* A NP problem may require one or two agents of motion to get the ball to the ball (0-1 point).
4. *Novelty.* This addresses whether a problem is novel relative to other problems played. Problem solution is not easily determined from experience with other problems (0-2 points).

Each problem is then evaluated under these rubrics to yield a difficulty score, and each of these rubrics contributes to the difficulty of the problem in a different way. Using these rubrics, a difficulty score can range from zero to six. For example, consider the problem cave story (Figure 3). This problem’s difficulty score is 5 based on the rubrics. Thus the cave story can be a good problem to assess persistence since it will likely be unsolvable to some students.



**Figure 3: Cave Story: A good problem for persistence assessment**

## Agenda

Our workshop will be organized as follows:

### Presentation (5 minutes)

We will share information about game-based assessment and discuss how ECD fits with game design principles. We will also discuss what item/task difficulty means in the game context, and how to create problems with varying difficulty in a game. Additionally, we will highlight some of the examples from our project in NP.

### Introduction to Newton's Playground (5 minutes)

We will share information about Newton's Playground, and briefly demonstrate how to solve problems and create new problems using the game editor. Mainly we will focus on demonstrating how to create *agents of motion* that players can use in NP to move the ball. Some of the agents of motion include:

### Develop, playtest, and revise Newton's Playground problems for persistence (40 minutes)

In small groups (of two or three), participants will create tasks of varying difficulty in Newton's Playground to assess persistence. Participants will playtest each other's tasks, and feedback for playtests will help participants revise their tasks.

### Present-out and discussion (10 minutes)

Participants will present their tasks and how their tasks function as assessments for persistence. The whole group session will be followed by a reflection on the experience from the workshop.

## Conclusion

We believe this workshop will benefit researchers, educators, and practitioners who want to use video games for learning and assessment. The focus of this workshop is designing problems in the game for assessment and support of learning. The idea of game-based assessment is still fairly new, and we believe this workshop will be a good venue to communicate ideas among participants with varying backgrounds. We further hope that this workshop will provide an opportunity for more people to understand that the fundamental philosophy of ECD is flexible enough to fit within diverse learning environments such as video games, and ECD can be a common language that game and assessment designers use to work collaboratively.

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# Evaluating STEM Games For Young Audiences: A Hands-On Workshop

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**Abstract:** Games and interactive media environments have been identified as promising tools for supporting STEM. This workshop includes facilitated guided play sessions through a curated group of games (mobile, web, and console), allowing participants to explore key aspects of games that teach a STEM mindset, including cooperation, trial and error, holistic thinking, and data visualization. Moderators will first present the challenges and opportunities supporting a STEM mindset through games, then model a playthrough of a selected game embodying key features. Participants will then be able to explore games on their own and with moderators before gathering again as a group to discuss their findings, where moderators will situate the discussion in the larger issues of STEM product design, implementation, and research.

## Playful STEM Development

Games and interactive media environments have been identified as promising tools for supporting STEM (science, technology, engineering, and math) readiness and education, from the youngest of players to high-performing professionals and academics. A STEM educated child embodies the following attributes: problem-solver, innovator, self-reliant, logical thinker, and technologically literate (Morrison, 2006; Fisher, Bryant, Akerman, and Fischer, 2010).

Sometimes fostering a STEM mindset is as simple as giving a child the space to wonder, and the tools and encouragement to try out ideas. For example, Figure 1 illustrates the creation of a 4-year-old who was engaged in the world and play of *Angry Birds*. He created his own angry birds, and with the assistance of a giftwrap ribbon for the slingshot and strategic placement of toys and furniture around the room, he began to create his own “levels” and attempt to model the system he had participated with in the game.



**Figure 1:** Exploring with Angry Birds: A Kid Creation.

Researchers from The Education Arcade at MIT propose that in any academic discipline, there are elements that are inherently game-like. This would include the sorts of questions that professionals and practitioners mull over, leading to “a-ha” moments (Klopfer, Osterweil, & Salen, 2009). According to the researchers, “for scientists it might mean constructing models of phenomena based on incomplete evidence, and then testing them (p.32).” The description of the STEM educated child aligns directly to the skills and behaviors applied by practitioners in STEM fields. By capturing the game-like experiences of experimenting, modeling, and discovering, games become tools for the STEM process that underlies content.

Children construct meaning not simply through the cultural and system representations that manifest in play, but by the process of play itself. And by asking how the world invites and even requires ‘activity’ on the part of the user, designers and producers can generate new worlds and environments that enable rich play and learning experiences. This should be applied not just to specific products and platforms (digital and analog games, interactive spaces, movies and storylines, etc.), but to the entire suite of products and platforms that make up a narrative world, and designed in such a way that deep exploration, user participation and activity, and creative boundary pushing of narrative world borders are not only allowed, but encouraged. Through these practices, deeper learning can take place. Thus, the experience of play in and of itself is at the heart of STEM educational experiences.

## **STEM Skills in Focus**

With so many products proliferating the market, particularly those claiming to have educational merit, how can developers, educators, and researchers evaluate existing products to identify critical elements of STEM play? Beyond this, how can researchers and developers understand media needs, trends, and opportunities in order to further develop STEM supportive products and platforms? This workshop proposes to begin to address that need by equipping educators, academics, and developers alike to critically think about game spaces through a STEM skills focus framework.

The specific STEM skills (as discussed in Fisher et al (2010)) that this workshop will focus on are:

- *Cooperation*, sharing of and listening to ideas and providing constructive criticism. Operating in a scientific world means to be part of the community of scientists, particularly as a member of a team. To do this successfully, one must have cooperative social skills such as listening, turn-taking, and honoring each others observations.
- *Trial and error* (finding multiple solutions): Practicing trial and error means moving away from a process-oriented pedagogy and toward one in which the child explores different pathways to an answer. In doing so, the learner experiences a key part of the innovation process – failure – and that failure can lead to the right answer.
- *Fostering holistic, systems thinking*: Exploring the world as a series of interrelated parts is another key skill. Simulations are a key part of this skill, particularly when the child can manipulate the parts of the simulation to understand the role of the variables in the overall system.
- *Collecting and visualizing data*: While the goal is straightforward, we’ll look at games that are unusual in their ability to visualize data, not just about flipping a coin repeatedly and seeing the results in a histogram.

## **Workshop Format**

The workshop leaders come from different areas of educational development, implementation and research. Drawing from their experiences, each workshop leader will facilitate guided play experiences with groups of workshop participants. The first phase of the workshop will consist of facilitators presenting challenges and opportunities around supporting STEM mindsets through games and interactive environments. Facilitators will then model a critical playthrough of a selected game that embodies STEM mindset practices in some way. Participants will be given tools with which to learn to evaluate games and interactive media for STEM practices. Following the demonstration playthrough, workshop participants will split into three groups: mobile, console, and PC. Facilitators will provide guidance as participants do critical plays of other games and interactive media. The final phase of the workshop will be to regroup and discuss findings from the playthroughs, specifically noting trends and opportunities, and applying findings to broader issues of STEM product design, implementation, and research.

Workshop participants will complete the session having had the opportunity to play with STEM supportive products and evaluate them using the *STEM Skills in Focus Framework* described above.

### **Example STEM Games and Interactive Spaces for Participant Evaluation**

Workshop facilitators will use games and media environments like those listed below in Table 1 to shape the play experience of session participants. This list is not exhaustive, but provides a foundation for understanding the variance in production quality and market prevalence of the products that will be evaluated by the workshop participants.

Product Title	Producer	Platform	Description	Media
World of Goo	2D Boy	iOS, PC, Wii, Android	Physics-based puzzle game in which players build structures using balls of goo to reach a target. Information at <a href="http://www.worldofgoo.com/">http://www.worldofgoo.com/</a>	Game
New Super Mario Brothers Wii	Nintendo	Nintendo Wii	Platformer multiplayer game that requires scaffolding and modeling for achieving goals. Information at <a href="http://mariobrosnii.com/">http://mariobrosnii.com/</a>	Game
Little Big Planet, Little Big Planet 2	Sony Entertainment, Media Molecule	PSP, PS3	Play, create, and share game levels. Information at <a href="http://www.littlebigplanet.com/en/">http://www.littlebigplanet.com/en/</a>	Game
The Hidden Park	Bulpadok	iPhone	An augmented reality game that brings magical creatures into your local park. Information at <a href="http://www.thehiddenpark.com/">http://www.thehiddenpark.com/</a>	Game
PlaceSpotting	Martin Fussen	Internet	A Google map quiz. Available at <a href="http://placespotting.com">http://placespotting.com</a>	Game
Teletubbies	PBS Kids	Internet	Available at <a href="http://pbskids.org/teletubbies/teletubbycland.html">http://pbskids.org/teletubbies/teletubbycland.html</a>	Game
Minecraft	Mojang	Internet	Open-ended world building game. Available at <a href="http://www.minecraft.net/">http://www.minecraft.net/</a>	Game
Portal & Portal2	Valve	PC, Xbox	A first-person physics-based puzzle game. Information at <a href="http://www.thinkwithportals.com/">http://www.thinkwithportals.com/</a>	Game
The Incredible Machine	Disney	iOS	Solve puzzles by building engineered contraptions to accomplish objectives. Information at <a href="http://itunes.apple.com/us/app/the-incredible-machine/id440297659?mt=8">http://itunes.apple.com/us/app/the-incredible-machine/id440297659?mt=8</a>	Game
Scribblenauts, Super Scribblenauts, Scribblenauts Remix	WB Games	Nintendo DS, iPad	An emergent puzzle action game in which players creatively solve challenges using nouns and adjectives. Information at <a href="http://games.kidswb.com/official-site/scribblenauts/">http://games.kidswb.com/official-site/scribblenauts/</a>	Game
Angry Birds	Rovio	iOS, Android, Internet, Other	A physics-based strategy game in which players use a catapult to launch birds and demolish targets. Information available at <a href="http://www.rovio.com/en/our-work/games/view/1/angry-birds">http://www.rovio.com/en/our-work/games/view/1/angry-birds</a>	Game
LEGO Junkbot	LEGO	Internet	A platform puzzle game that uses LEGO pieces to reach the garbage. Available at <a href="http://tinyurl.com/ms3s">http://tinyurl.com/ms3s</a>	Game
Goldwalker	Humana, Inc.	iOS	Augmented reality adventure strategy game. Available at	Game

			<a href="http://itunes.apple.com/us/app/goldwaIker/id372683234?mt=8">http://itunes.apple.com/us/app/goldwaIker/id372683234?mt=8</a>	
Rock, Paper, Scissors vs. Computer	Created by Gabriel Dance and Tom Jackson	Online	A crowdsourced game that analyzes player input to make decisions on patterns of play. Excellent for visualizing artificial intelligence reasoning. From the NY Times, Available at <a href="http://tinyurl.com/4tf3oct">http://tinyurl.com/4tf3oct</a>	Game
Eyeballing Game	Woodgears.ca	Online	A geometry-based estimation game with visualization of player performance data. Available at <a href="http://woodgears.ca/eyeball/index.htm!">http://woodgears.ca/eyeball/index.htm!</a>	Game
Meanwhile	Written by Jason Shiga	iOS	Originally a book and now an app, based on Scott McCloud's principle of the infinite canvas. Information at <a href="http://zarfhome.com/meanwhile/">http://zarfhome.com/meanwhile/</a>	Interactive Book/App
Little Big Planet Level Builder	Sony Entertainment, Media Molecule	PS3, PSP	Built in to the game, the level creator allows players to customize levels and challenges, and share with other players in the Little Big Planet Community. Information at <a href="http://www.littlebigplanet.com/en/community/">http://www.littlebigplanet.com/en/community/</a>	Game Creation Tool
Scribblenauts Level Editor	WB Games	DS, iOS	A visually supported modding tool for previously created Scribblenaut levels. Information at <a href="http://www.scribblenautsguide.com/page/Scribblenauts+Level+Editor">http://www.scribblenautsguide.com/page/Scribblenauts+Level+Editor</a>	Game Creation Tool
Inform 7	Inform	Online	Interactive Fiction game creator. Available at <a href="http://inform7.com/">http://inform7.com/</a>	Interactive Fiction Creation Tool
Scratch	MIT Media Lab	Online	Visual programming tool and creation sharing community. Available at <a href="http://scratch.mit.org">http://scratch.mit.org</a>	Game Creation Tool

**Table 1: Example STEM Games and Interactive Spaces.**

### Workshop Leaders

The workshop leaders come from different areas of media design, implementation, and research.

#### *Carla Engelbrecht Fisher*

The founder of No Crusts Interactive, Carla Fisher is a game designer with a research obsession. Having spent more than a decade making children's digital goods, she's produced, researched, and consulted on a wide variety of commercial and educational products, from Web to mobile to console, including the Nintendo Wii and DS as well as the Xbox 360 Kinect. Before starting No Crusts Interactive, she worked for Sesame Workshop, PBS KIDS, and Highlights for Children. Carla is a published author as well as a recent PhD graduate of Teachers College, Columbia University, where she studies technology and its relationship with human cognition and development, particularly as it applies to children and games. She defended her dissertation, entitled "Adolescents, Video Games, and the Displacement Effect" in February 2012. Carla holds a master's degree in media studies from the New School University and has, on occasion, been known to twist balloon animals and hats.

#### *Meagan K. Rothschild*

Meagan Rothschild is a PhD candidate, Instructional Designer and Educational Programs consultant in Madison, Wisconsin. She currently works with the Morgridge Institute for Research in the Educational Research Integration Area, which specializes in designing and researching interactive digital media and systems for learning. Prior joining the Games, Learning, and Society group at UW-

Madison, Meagan served as the Instructional Designer for *Cosmos Chaos!*, a video game designed to support struggling fourth grade readers developed by Pacific Resources for Education and Learning (PREL). Her experience at PREL also included the design of a violence and substance abuse prevention curriculum for Native Hawaiian students, using an interdisciplinary approach that merged health and language arts content standards to support literacy-driven prevention activities. Meagan has six years of experience in the Hawaii Department of Education system. Meagan has a BA and MEd from the University of Hawaii at Manoa, with undergraduate studies in Hawaiian Language and special education, and a post graduate degree in Educational Technology. As a PhD student, her work now focuses on planning and developing multimedia environments that merge research-based educational principles with gaming strategies to engage learners.

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## Acknowledgments

The workshop facilitators wish to extend thanks to Scot Osterweil and David Kanter for their input in presenting challenges and opportunities for STEM education and providing examples of playful STEM environments.



## The Metagame as Teaching Game

Colleen Macklin, Associate Professor, Design and Technology program, Parsons the New School for Design

John Sharp, Assistant Professor, School of Literature, Communication and Culture, Georgia Institute of Technology

Alice Daer, Assistant Professor, English Department, Arizona State University

Sean Duncan, Assistant Professor, School of Education, Health, and Society & Armstrong Institute for Interactive Media Studies, Miami University

Andrew Nealen, Assistant Professor, Computer Science, Rutgers the State University of New Jersey

"Games are popular art, collective, social reactions to the main drive or action of any culture. [They]...are extensions of social man and the body politic...As extensions of the popular response to the workday stress, games become faithful models of a culture. They incorporate both the action and the reaction of whole populations in a single dynamic image.... The games of a people reveal a great deal about them."

— Marshall McLuhan, *Understanding Media: The Extensions of Man*

This paper and the workshop that we propose herein explores the *Metagame*, a card game in which players pose arguments about cultural artifacts like games, films, literature, design and fashion, as an educational tool for a variety of uses. We hope to use the workshop to introduce educators to the cards, to demonstrate and discuss some of the games and pedagogical goals that can be addressed through these games, and have participants develop new game variants and educational applications. We see the workshop as valuable for three key reasons: to expose educators to a flexible teaching tool, to the ways in which cultural literacy can be developed through playful debate and to gain insight in how to shape the game for future releases (two of the authors, Macklin and Sharp are co-creators of the game).

There are currently two versions of the *Metagame*: *The Culture Edition 1.0*, and the *Videogame Edition 1.0*. The *Culture Edition 1.0* was published in issue 17 of *Esopus* magazine. Each issue had one of three decks composed of 80 content cards and 40 comparison cards bound into it. The content of the *Culture Edition* includes 20<sup>th</sup> century examples of architecture, art, comics, fashion, film, games, literature, music, product design and theater. The *Videogame Edition 1.0* is composed of videogames from the 1970s to the present.

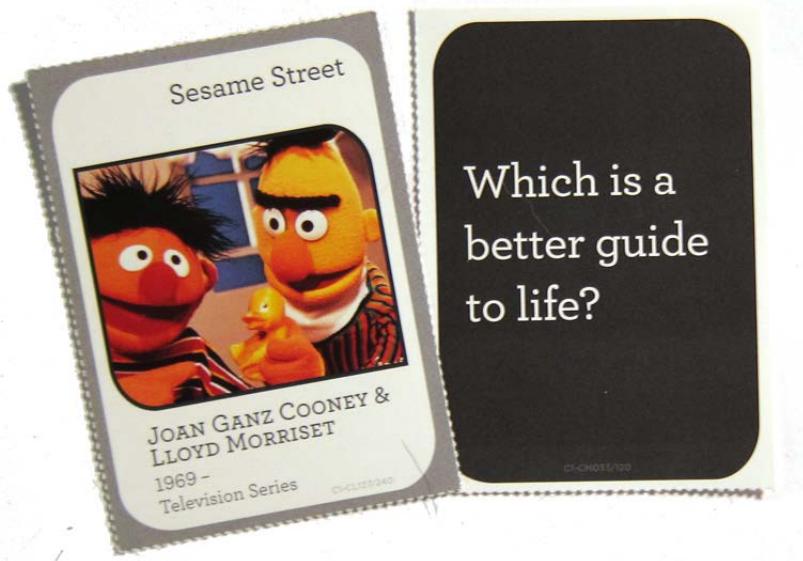
Each Metagame deck contains two kinds of cards.



**Figure 1:** First, there are content cards, which contain the cultural artifacts (all card images drawn from the *Culture Edition 1.0*).



**Figure 2:** The second type of card is the comparisons, which are used as the basis of debate and discussion.



**Figure 3:** The basic game involves two players and one or more judges. The first player selects one content card and one comparison from their hand.



**Figure 4:** The other player picks a content card from their hand that they believe better matches the comparison.

The first player has up to two minutes to persuade the judge why their content card better fits the comparison. The second player then has two minutes to make their argument. The judges then decide who made the better argument.

The *Metagame* is at its heart a game about aesthetics. We use aesthetics here in the contemporary sense—the logical determination and evaluation of an artifact’s purpose and value. In this light, the *Metagame* requires players to think deeply about the cultural artifacts in their lives, and asks them to construct concise, persuasive arguments to support their opinions. The construction of arguments can be difficult, but within the structure of the *Metagame*, the comparison and contrast structure facilitates; by having the players use a shared comparison, the game creates a frame around the debate, and gives the two players and the judge a set of constraints within which to operate.

We have discovered through our own design planning and player response, that the basic structure of the *Metagame* decks and its focus on the construction and adjudication of aesthetic arguments is immensely flexible. It does, however, require a substantial knowledge around the subject domains represented on the content cards. For example, for most young people in their teens and early twenties, the *Videogame Edition 1.0* presents few if any games that the players are unfamiliar with. The *Culture Edition 1.0*, on the other hand, tends to work better with players in their 30s and 40s who have a general interest in the arts and popular culture.

In the case of the *Videogame Edition*, we have noticed that players tend to want more granular cards within franchises. For example, we receive questions about why we included Naughty Dog’s *Uncharted 2*, but not the original *Uncharted* or the more recent *Uncharted 3*. Similar questions arise around genres—why *Halo* and *America’s Army* but not *Red Faction* and *Call of Duty: Modern Warfare*? Ultimately, both editions of the *Metagame* seem infinitely expandable. In March 2012, we released the *Videogame Expansion 1*, which broadens the cards in circulation by 30 games and 15 comparisons. As we further develop and expand the *Metagame*, we also foresee versions of the game that focus on more granular subject domains; to supplement the *Culture Edition*, which broadly but shallowly covers popular culture, we could create a Film expansion, or American Film expansion, or even American Independent Film expansion.

The challenges with the content cards appear to be a matter of cultural literacy within the subject domains. In order to play the videogame version, for example, a player needs to have played games across the forty years of commercial videogames from a wide range of genres and platforms. Or to play the *Culture Edition*, a player needs to be familiar with canonical artifacts from the breadth of twentieth and twenty-first-century material culture and media.

Playing either version of the *Metagame* often feels daunting, but for players willing to commit, the game proves to be a catalyst for developing a deeper awareness of the content base. For example, at GLS 2011, we observed a number of players looking up games they did not know on Wikipedia and Moby Games. In later play sessions, players appear to have gained familiarity with content they previously were unable to confidently speak to. Variations on the game as well lend themselves to players finding a comfortable role for themselves in the *Metagame*. In other cases, we have seen “house rules” develop in which players can pass on a content card if they are not familiar.

The *Metagame deck* has proven to be quite flexible in terms of content, types of games that can be played with it, the number of players it can support, the contexts in which it can be played, and the pedagogical uses for which it can be utilized. We view the *Metagame* deck and its two parts—content and comparison—to provide a flexibility not unlike a traditional deck of playing cards and the hundreds of game variations played with the same 52 cards, from *Go Fish* to *Poker* and everything in between. Thus far, we have designed and made available to the public five versions of the *Metagame*: basic (as described above), Duel, Knockout, Snap Decision, Verdict and Massively Multiplayer Metagame. Players have also created variants to suit their interests, level of game literacy, limitations on the number of players and other factors. (Our variants and player variants can be found on the *Metagame* website, <http://metaga.me>.)

Massively Multiplayer Metagame scales the basic game (two players and a judge, each player presenting a brief argument) from a dozen to several thousand players. We have successfully run or heard of MMM being run for upward of three thousand players at the Game Developers Conference 2011 and 2012 or approximately 250 players at GLS 2011 to a group of twenty or so students in the incoming cohort of the Interactive Media Program at the University of Southern California. In large-scale instances, we have noted a number of strengths for the use of the game including functioning as an ice-breaker for people to get to know one another, and to put a game wrapper around the deeply-engaged conversations people already like to have around culture and its artifacts.

Verdict is a strategic game for two players and a judge. Each round, the two players take turns putting down cards to match a set of comparisons selected by the judge. The judge then picks the winner of each comparison and players get points for each comparison they win.

Verdict dispenses with debating. As a result, players are able to engage with the game, and to assert comparative aesthetic arguments without having to speak. This version of the *Metagame* works well as a way to ease players into the basics of the *Metagame*, and allows quieter players an opportunity to participate without having to be too much in the spotlight. Verdict also puts players in direct contact with and develops comfort around questions and situations that do not have “absolute” or “correct” answers.

Finally, Knockout is an argumentative game for five or more players. Each round, players argue why their content card should win the current comparison. The player who makes the worst argument gets knocked out and joins the judges. The last player remaining is the winner. There are two key strengths with Knockout. First, the game keeps everyone engaged; to lose a round only means that you change roles from a debater to a judge. Second, the game allows players less comfortable with debating to ease into the role of judge, where they still have a meaningful role in the game.

Each *Metagame* variant allows different levels of engagement and participation. In fact, through forums and social media we’ve learned that some teachers are bringing the decks into their classrooms for a variety of subjects. These educators have also created variants on the game—turning a game designed for entertainment into a learning tool used to spark writing assignments, formal debates, and deep levels of criticism in the classroom.

To continue supporting the educational community and its use of the *Metagame* decks, we propose a two-hour workshop to both share the *Metagame* with new educators and to develop new uses of the game for educational contexts. Macklin and Sharp, two of the three creators of the *Metagame*, will run the workshop. Daer, Duncan and Nealen, who have all used the *Metagame* in college classrooms, will participate in the panel and help facilitate attendee activities.

- Introduction (5 minutes)  
A brief introduction to the basics of the *Metagame* and its history

- Play the *Metagame* (15 minutes)  
Workshop attendees will play the basic version of the *Metagame* to help them become familiar with the way the game works.
- The *Metagame* in the Classroom Panel Discussion (20 minutes)  
A group of educators using the *Metagame* in the classroom will discuss their pedagogical goals and techniques. Emphasis will be placed on thinking through the places where the game can and cannot be of pedagogical use.
- *Metagame* Variants (15 minutes)  
To give workshop attendees a broader sense of the ways the *Metagame* deck can be used, we will introduce three to five games designed for either deck.
- Make a *Metagame* Exercise (20 minutes)  
Workshop attendees will work in groups organized around educational disciplines to design *Metagames* for use in the classroom. Groups can change and refine any aspect of the game: content, number of players, how arguments are presented, how judging occurs, context for play, etc.
- Playtest (20 minutes)  
Groups will playtest their *Metagames* with other groups to help refine the game designs.
- Conclusion (25 minutes)  
We will wrap up the workshop including collecting the variations designed with the goal of making the versions available online for other educators.

The workshop will help us better serve the education community by giving us an opportunity to get feedback on how we can support the game's use in educational contexts. It will likewise give educators exposure to the game and to the ways it can facilitate a variety of learning goals. Could the *Metagame* become part of the arsenal of 21<sup>st</sup> century learning tools as ubiquitous and versatile as a deck of cards in playful contexts and as essential as a textbook in learning environments? It would certainly be surprising if it did, in its quaint 18<sup>th</sup> century form as a simple deck of cards. However, a flexible platform that asks us to reflect on the meaning and significance of our cultural world with each other seems to have special relevance in today's increasingly mediated moments.



## **SHORT PAPERS**



## **Educational Game Arcade**



# **Leo's Pad**

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## **Introduction**

Our plan for this paper is to describe *Leo's Pad* using a framework based on the seven circumstances of a rhetorical hypothesis developed by the ancient Greeks (Arena, 2011). At the time of this writing, the pilot "appisode" of *Leo's Pad* is in fully playable beta.

## **Who is the learner?**

Our initial audience is a child between three and five years old who is able to use an iPad on a regular basis and can follow simple instructions spoken in English.

## **What is being learned?**

Our curriculum (spanning 30 appisodes) will support 28 dimensions of proficiency across four categories: Academic (e.g., literacy, numeracy); Cognitive (e.g., attention control, delay of gratification); Physical/sensory (e.g., fine-motor skills, speech comprehension); and Social/emotional (e.g., empathy, growth mindset).

## **When does the learning occur?**

*Leo's Pad* is an interactive story consisting of a connected series of appisodes. Each appisode intersperses narrative video segments with games, puzzles, and projects. Some learning will have occurred before gameplay, in which case the games will provide an opportunity to gain fluency (e.g., with counting or simple arithmetic). Most of the learning will happen during gameplay, where "gameplay" includes both the passive and active parts of the story—seeing the characters model turn-taking, for example, or learning the meaning of new words, or learning to differentiate when presented with contrasting cases. And finally, we will have an assessment and parental feedback loop, through which we will help parents understand effective ways to support their children's subsequent learning based on their gameplay experiences.

## **Where does the learning occur?**

As indicated above, learning will primarily happen within the game, but our parental feedback loop will support learning outside of the game in the informal "parental curriculum" space.

## **Why is the learner playing?**

A child will play *Leo's Pad* for fun, because he or she enjoys the interactive social narrative of a group of slightly older peers inviting the child to join them for games, projects, and adventures. A grown-up will probably provide the child with *Leo's Pad* not only because it is fun but also for the more instrumental reason that it may help the child's development.

## **How does the learning occur?**

The narrative video segments will offer moments of modeling and direct instruction. The interactive elements will offer opportunities for guided exploration with corrective feedback, plenty of trial-and-error, and possibly some drill-and-practice to improve fluency. Within each appisode, at least one game will be designed for intergenerational co-play, allowing a grown-up to directly scaffold the child's learning. Each appisode will likely be experienced multiple times, providing ample opportunity for repetition of both video and gameplay.

## **With what does the learning occur?**

*Leo's Pad* is a commercial application that will be available through the iTunes store and perhaps eventually other tablet platforms as well.

## **Screenshots**

The screenshots below come from the pilot appisode of *Leo's Pad*. First is Leo's house; then a hide-and-seek game with Cinder the baby dragon; then building a piece of Gally's birthday present (a

telescope); then flying to Gally's house for his birthday party (while Cinder blows smoke puffs); then Leo (and Cinder) introducing Gally; and finally, looking through Gally's telescope.



## References

Arena, D. (2011, June). The seven circumstances of game-based learning (a worked example and an invitation). In the *Proceedings of the Games, Learning, and Society Conference 7.0* (p. 31-38). Madison, WI: ETC.

## Acknowledgments

Orange Design wrote the software for the pilot appisode of *Leo's Pad* and collaborated on elements of game design, and Prana Studios provided all animation and most of the graphical assets. A collaborator who wishes to remain anonymous wrote the script.

## Meet the Earthworks Builders Video Game

Michelle Aubrecht, Ohio State University, Art Education, 1961 Tuttle Park Pl., 1<sup>st</sup> Floor, Columbus, OH 43210, [Aubrechta@columbus.rr.com](mailto:Aubrechta@columbus.rr.com)

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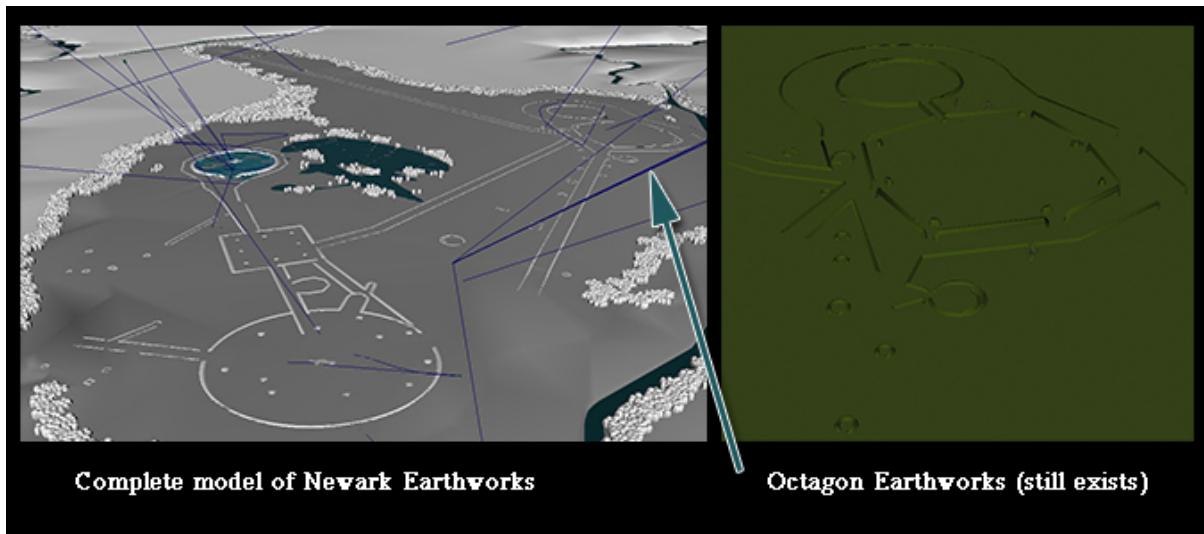
Dan Norton, Filament Games, 2010 Eastwood Dr., Suite 104, Madison, WI, [norton@filamentgames.com](mailto:norton@filamentgames.com)

### Concept

Funded by the National Endowment for the Humanities (NEH), *Meet the Earthworks Builders* is about understanding the Newark Earthworks as a lunar observatory.

### Game Play

The player may navigate among a series of panoramic vistas in a style similar to *Myst*, by clicking on hotspots. The actual Newark Earthworks is several miles wide and we are using an accurate 3D model provided by CERHAS and John Hancock who is a content advisor on this project (Figure 1).

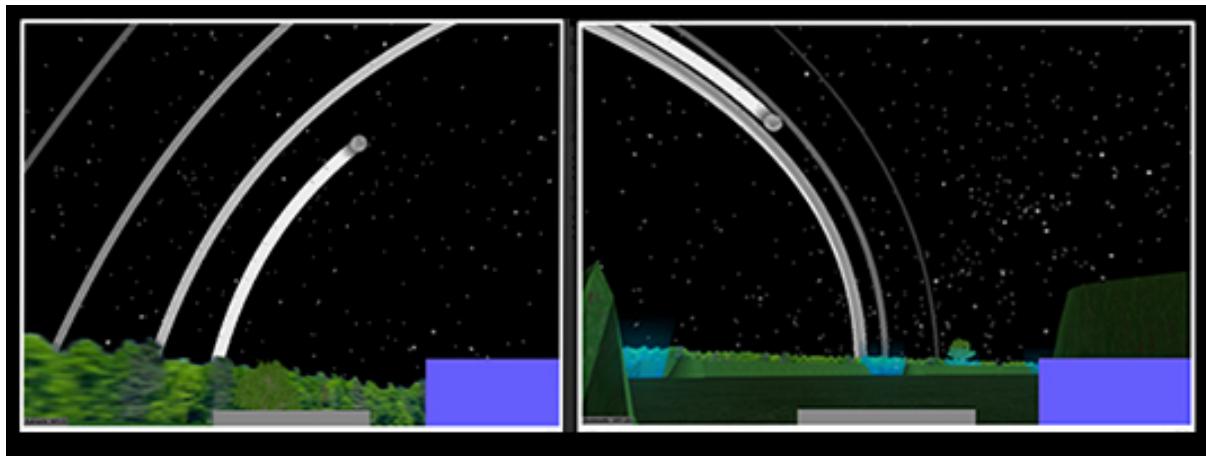


**Figure 1**

In this game environment, the focus is on the sky and the cycle of the moon. The user interface gives the player information about the moon for day, month, and year. The Newark Earthworks is structured to observe the Northern most lunar standstill that occurs every 18.6 years. Observing this is the win state and the player must stand on the observatory mound, facing the right direction on the right year of the cycle. Hence, players must manipulate time, position, and orientation in order to advance. To reach this goal, the player will unlock a series of moon positions by collecting markers that correspond to the monthly and yearly cyclical movements of the moon traversing minor to major standstills.

Cycles lend themselves to discovering patterns and that makes for great game mechanics. The primary objective of the game is for the player to predict where the moon will rise and thus, building upon a natural pattern of movement, players will “catch the moon,” which results in players receiving environmental enhancements such as brighter stars, the Milky Way, animated constellations, and added sounds such as bird calls, wind, and water. Players will identify moments where time, position, and orientation intersect to reveal lunar events.

To help the player understand the moon’s trajectory, a procedurally animated trail shows where the moon has been and remains for several rotations, but narrows and fades (Figure 2).



**Figure 2**

## Cultural Representation and Art style

Because we want to avoid stereotypical representations of Native Americans, we opted to create a game that does not represent humans at all. We are focusing on the sky as the primary area and anticipate adding more constellations and supporting narrative and oral storytelling through the companion website in the future. With over 500 Native American Tribes and Nations in the United States, there are multiple stories about the same constellations or parts of familiar constellations. For example, the Big Dipper's bowl is referred to as the Celestial Bear by the Micmac. We are focusing on culture groups from the Northeastern United States since the Newark Earthworks is located in Ohio.

We are using an accurate star map found online which has been modified by Paul Bourke in order to be wrapped to a sphere (<http://paulbourke.net/miscellaneous/starfield/>). On this star map, with help from our science education consultant, Bill Schmitt, we identified several constellations.

## Learning Objectives

### Primary Learning Objectives

- “Look up”, noticing the stars, moon and spatial relationships with the earthworks
- Experience through simulation that the Earthworks are a ruin of a lunar observatory and the Octagon precisely tracks the northern-most moonrise.
- Gain a sense of the scale of the Earthworks (the great circle  $\approx 1,054\text{ft}$  in diameter).
- Grasp historical period/concept of timelines (300 B.C.-400A.D.; Middle Woodland Period)

### Secondary Learning Objectives

- Challenge and grow knowledge of Native American accomplishments
- Reconsider stereotypes about Native Americans

### Working assumptions

- The mounds were built by an indigenous population whose descendants are living today.
- Players will understand Native Americans as sophisticated people who were able to construct a complex, accurate, large-scale lunar observatory.

## Notes

Development Blog: <http://meet-the-earthworks-builders.posterous.com/>. We intend to continue to refine this prototype through playtesting during the summer of 2012 and take it into classrooms in the fall of 2012. We intend to seek additional funding to expand and refine the game as playtesting continues. To provide your feedback, please contact [earthworksbuidlers@gmail.com](mailto:earthworksbuidlers@gmail.com). This Flash game is free and available online at: <http://earthworksbuidler.github.com/>.

## Acknowledgments

This project is made possible through funding from the National Endowment for the Humanities and in-kind contributions from the Ohio State University. We are grateful to our Content experts who include Native Americans, especially our PI, Christine Ballengee-Morris, professor, (Art Education, OSU), as well as John Hancock, University of Cincinnati, Center for the Electronic Reconstruction of Historical and Archaeological Sites, for providing the 3D model of Newark Earthworks.

# IPRO: A mobile, social programming game for iOS

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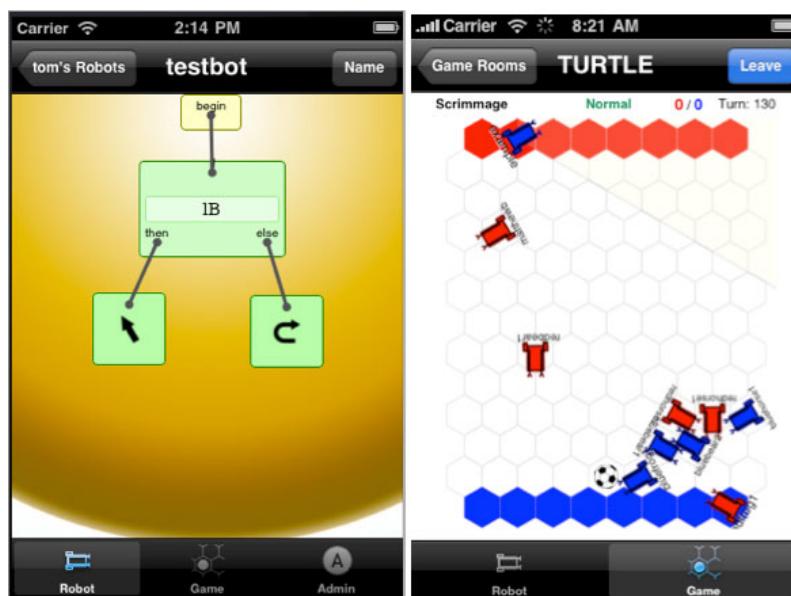
Email: [tmartini@mail.utexas.edu](mailto:tmartini@mail.utexas.edu), [tom.benton@austin.utexas.edu](mailto:tom.benton@austin.utexas.edu), [carmenpetrick@gmail.com](mailto:carmenpetrick@gmail.com)

IPRO (“I can PROgram” or “IPod RObotics”) takes a novel approach to developing proficiency in computer programming by reframing programming as a game while integrating mobile and social affordances into an accessible environment in which users can program virtual soccer-players. In short, IPRO is designed to fight stereotypical perceptions of programming as solitary, stationary, and possessing a steep learning curve.

This project is rooted in a constructionist framework (Papert, 1980) in which content learning is reinforced by constructing artifacts. The artifacts (soccer player programs) support complex learning in several ways, as users can: test their robots; compete against their peers; and quickly refine programs.

IPRO is an iOS application for iPhone and iPod Touch. Placing the game on a mobile device permits new capabilities that contribute to learning as well as fun. Though an IPRO program can become very lengthy and sophisticated using nested conditional blocks, the building blocks of an IPRO program are relatively simple combinations of observations and actions. Being able to physically move while programming allows users to “play robot,” troubleshooting their own programs with their hands and feet (Petrick, Berland, & Martin, 2011). Students can also easily interact with their peers: collaborating, critiquing, asking for help, and showing off their work.

IPRO utilizes a Scheme-derived visual programming language drawing from a library of sensors, actions, and basic logic operators. Sensors allow the robot to assess the state of the field, detecting the ball, the goal, or other players. Actions permit the robot to turn or move forward or backwards. The most vital logical element is the conditional block, which links actions to sensor output. Figure 1 (left, below) shows a basic IPRO program as well as a match in action. In the program we see the left ball sensor (IB) linked to two actions: move forward left or turn right.



**Figure 1:** A basic IPRO program (left) and an IPRO match in progress (right)

In ‘Solo Play’ mode, learners can see their robot in action and confirm that it is performing as expected. When there exist multiple robots on the field, robots take turns executing their programs until the completion of the match. Accounting for opponents, teammates, and a moving ball can make Match Play a far more challenging situation than Solo Play. A match in progress appears in Figure 1 (right, above).

In a pair of studies, secondary school students reported IPRO to be engaging and demonstrated learning gains in IPRO programming as well as basic logic transfer tasks. While learning gains were largely correlated with experience programming, students with less experience reported increased comfort with programming in general (Martin, Berland, & Benton, in press). Currently we are exploring how data mining and techniques from learning analytic techniques can be used to describe student learning pathways based on the extensive IPRO data logs of programming activity.

We hope to have many people playing IPRO both competitively and cooperatively through the arcade and around the conference. Anyone with an iOS-compatible device should be able to play freely.

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# School Scene Investigators: Evaluating Engagement during a Forensic Science Mystery Game

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**Abstract:** Sixty-eight middle school students played *School Scene Investigators: The Case of the Stolen Score Sheets*. Developed explicitly for this study, the game was built using ARIS and utilized quick-response codes set around the school environment. Working in groups, students played unique roles, collected and synthesized virtual forensic evidence, and solved the mystery. Evidence was collected in several forms: pre-surveys, post-surveys, field observations, and focus groups. Quantitative data was analyzed using a hierarchical multiple regression model. Qualitative data was thematically analyzed using qualitative analysis software. A merged analysis revealed that gender does not statistically predict engagement, yet different game elements engage genders differently. Interest in science does not predict engagement, although playing the game seemed to increase interest in science. Gaming attitudes predicted 23% of the unique variance in engagement level. Lastly, the engagement instrument showed all players were experiencing flow.

## Introduction

Pure engagement in an activity can be characterized by the theory of flow as developed by Csikszentmihalyi (1990). Over the past 15 years, researchers have been studying flow in technology mediated learning environments. Cooper (2010) conducted a review of such published studies and concluded that, "studies indicate a positive relationship between flow and learning in technology environments" (p. 4). Given this positive relationship and the documented findings of high engagement during handheld augmented reality games (Dunleavy, Dede, & Mitchell, 2009), this research study sought to gain a deeper understanding of learner engagement, or flow, during a mobile augmented reality (AR) science game. Engagement was measured quantitatively using a self-report survey that empirically assessed flow. Examples of Likert-style survey items included: "I was challenged and I felt I could meet the challenge" and "I was totally focused on what I was doing." Based on the literature, several variables were included in the regression model: interest in science (Shernoff, Csikszentmihalyi, Schneider, & Shernoff, 2003; Singh, Mido, & Dika, 2005), gaming attitudes (Bonanno & Kommers, 2008), and gender (Gardner, 1998; Hoffman & Nadelson, 2010). Students were also observed during gameplay and interviewed in focus groups.

Using a mixed methods approach, this study researched the following questions:

1. How much variability in engagement level in a mobile AR science game is explained by gender?
2. Controlling for gender, do interest in science and gaming attitudes account for significant variability in level of engagement in a mobile AR science game?
3. What are the components of the engagement experience for middle school students while playing a mobile AR science game?

## Game Overview

*School Scene Investigators* is a mobile learning game where students investigate 'crimes' that occur at their school. The first fully operational game was *The Case of the Stolen Score Sheets*. Players used forensic science to analyze the evidence and solve the mystery. This narrative-driven, inquiry-based game was played on iPhones supplied by the University. As students moved throughout their school building, they encountered quick-response codes (QR codes) that they scanned to access relevant game information. Triggered events included meetings with virtual characters and the retrieval of evidence.

The game was played in groups of three or four students. Each student had a unique role: techie, photographer, social networker, or science whiz. When groups had only three individuals, no one played the photographer; game design allowed for this role to be non-critical. Based on their roles, players were provided with different pieces of information as they progressed through the game. Players had to share information to navigate through the game and solve the mystery.

Throughout the game, players were exposed to basic elements of forensic science, like analyzing fingerprint, hair and other trace evidence. In order to complete the game, students utilized basic skills in observation, data collection, and data analysis. Players were challenged to synthesize several pieces of data in order to reach a conclusion. This enrichment activity concluded with a win-state; teams figured out which suspect committed the crime.

This game broke new ground in terms of its design. It took advantage of the medium's affordances, yet minimized some documented limitations (Dunleavy, Dede, & Mitchell, 2009). First, the game was played inside to minimize the influence of outdoor environmental factors. Second, the game relied solely on wireless Internet and QR codes to reduce technical difficulties and frustrations caused by GPS error. Finally, the game was situated in a location yet scalable. It utilized generic school locales such as a library, gym, principal's office, etc. This structure allows any middle or high school teacher to implement the game simply by printing out the QR codes and posting them in relevant locations.

## **Methodology**

Data collection took place during March 2012. A convenience sample of 68 middle school students was obtained from a diverse, urban area in Pennsylvania with mostly low-income households. Data was collected in quantitative (pre-surveys and post-surveys) and qualitative forms (focus group discussions and field observations). During analysis, data sets became interactive to allow for a merged analysis. A hierarchical multiple regression analyzed how well gender, interest in science, and gaming attitudes predicted engagement level during the game. Focus group transcripts were coded to look for repeating themes and concepts in order to evaluate the components of students' engagement and confirm the reliability of the quantitative study.

## **Results and Discussion**

First, as measured by the engagement instrument, all players experienced flow. Field observations supported this finding and students referenced different aspects of flow during focus group interviews. High engagement seemed attributable to certain game design elements; frustration and cognitive overload were lowered due to reliance on wireless Internet and QR codes. Second, gender did not predict engagement level; boy and girls were equally engaged albeit by different game elements. Boys seemed more apt to enjoy using the phones and scanning the codes; girls referenced the storyline. Third, kids were engaged regardless of interest in science. Better yet, the way players experienced science within the game seemed to change their perception of science, which increased their interest. Finally, gaming attitudes statistically predicted 23% of the unique variance in engagement. Enthusiastic gamers experienced higher levels of flow while playing, probably due to their comfort with the game format and previous gaming experience. Overall, these research findings support a closer look at using mobile AR science games as way to engage a critical population in STEM areas by providing opportunities to have fun with science and to feel capable of success.

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# The Battle for Dondervoort: Using the powers of pervasive games and play communities in education

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*"What are you? A fortification master? Cool. I'm the counsel."* (student, 14 years, 2010)



Which character suits you best?



The interface of the game

## The Battle for Dondervoort

*The Battle for Dondervoort* is a pervasive, social school game developed with students and teachers, that teaches youngsters (ages 12-15) about an important and unique part of Dutch history in a rather unconventional and innovative way.



Do the loyal civilians win at the end of the week?



Or the traitors?

## The game

The game transforms the classroom for a week into the fictional fortified city named Dondervoort during the Dutch Eighty Years' War (1558-1648). Every student has a custom-made house and plays a different character in this city, for example a fortification master, a host, a carpenter, a thief, a metal worker, the counsel, a noblewoman and so on. The goal of the class is to defend their city from the Spanish invaders, which attack every night. In order to do so, they have to work together and share information with the rest of the class that *only* their character has received by mail. But they need to be aware; there are also traitors among them who secretly work for the Spaniards. Who to trust? And who wins the game at the end of the week: the loyal civilians or the traitors? During the week teachers from different classes can also use *Dondervoort lessons* to support the game experience. In these lessons students can earn game assets. At the moment, teaching packages are available for *History*, *Mathematics*, *Arts*, and *Gymnastics*.

At the end, students will make a field trip to a fortified city nearby their school to play *Urban game*. Similar to the school game, the students have to prevent secret saboteurs from causing misfortune.

Therefore, they have to discover important buildings in the city and expose the saboteurs. This way the students also visit a real fortified city and are able to associate Dutch history with the present.

For More information (in Dutch):

[www.slagomondervoor.posterous.com/](http://www.slagomondervoor.posterous.com/)  
<http://www.slagomondervoor.nl>



View of the fictional fortified city of Dondervoort



Every student owns a house in Dondervoort

## Powers of pervasive games and play communities

The game uses the powers of pervasive and social gaming principles to motivate and educate. These principles are:

- Using the strengths of the play community, as defined by DeKoven (2002), to let students educate each other. In the beginning students take a test that appoints them with a suitable character in Dondervoort. The game encourages them to share the unique pieces of information given to the character. This way, the students teach each other. This is an important strength confirmed by the teachers involved.
- The game is pervasive: you can play it anywhere and at any time during the week. It blurs the boundaries between game and not-game, spatial, temporal, and social (Montola, 2009). By doing so, it also blurs the boundaries between lessons and not-lessons, school and not-school, learning and not-learning. The game uses and creates an active play community outside the classes (in breaks and at home) to share information. Testing revealed that students do this a lot.
- The game combines the strengths of digital technologies and real life. You cannot win the game by just clicking your mouse. You need to work together (talk, fight, stalk, negotiate, etc.) in real life too. This perfectly fits the post-digital world these students live in (Copier, 2007).



Students testing the game

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# Visual Literacies: From Print to Screen

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## Picturing the UP – The Game

*Picturing the UP* is a quest-based iPhone/iPad educational game created in the ARIS learning environment platform. The game situates contemporary digital photography in relation to historic archival research, as well as mobile technologies. In this game, players visit historical locations in the Upper Keweenaw Peninsula in order to learn more about their histories and to compare the past and present. More specifically, players first encounter a historical photograph of the location, and then meet a location guide that provides historical background. Next, they access a contemporary photograph of the location and receive a secret prize.

The game was created in a Fundamentals of Digital Imaging class as a pedagogical tool for understanding digital photography and digital imaging in a larger historical as well as technological contexts. The students in the class conducted three photo-shoots, created mobile images in Photoshop, conducted historical research and prepared the historical narratives for the game. I organized their visual and textual data into narrative quests using the ARIS Platform.

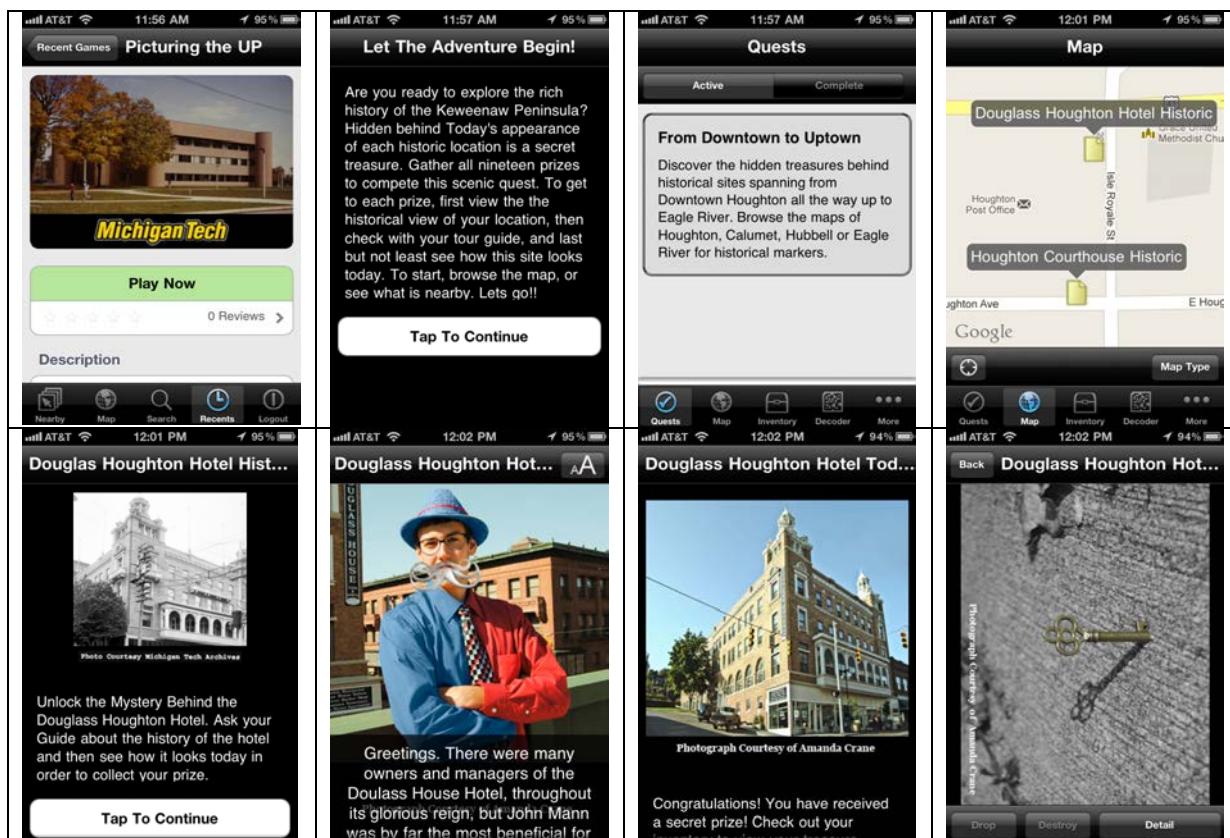


Figure 1: Screenshots from the game.

## Engaging New and Old Technologies

As every year new visual technologies enter our society, it is important to provide media students with analytical frameworks that allow for comparative media analysis, connecting “new”, “current” and “obsolete” media. Digital camera photography thus should be situated in the larger historical trajectory of analog photography as well as in the emergent field of cell-phone photography. The emphasis on the importance of history in understanding contemporary technology is further underscored when the subject photographed is also situated within a larger historical archive. Thus engaging with archival prints offers insight both into the development of the photographic technology itself but also of the cultural and socio-historical contexts. Adapting digital photographs for mobile games on the other

hand, opens up questions about the storytelling powers of visual technologies, as games provide “means for producing new forms of narrative” (Gordon, 2011: 6).

The *Picturing the UP* game engages with two major strands of digital media, namely locative arts and historical games. As a locative media game, *Picturing the UP* engages the notions of mobility and mobilization as synchronous as well as anachronous experience as it builds upon “the exploratory movements of locative art [that] are located between the art of communications and networking and the arts of landscape, walking and the environment” (Hemmet, 2006, p.348). As a history-driven game, it provides an opportunity for both the authors and the players of the game to engage with an augmented view of reality, where history acts as a supplement to the contemporary physical presence. As a history-based game, it also allows both parties to enter the historical research process and become visitors, photographers, gamers, and most importantly, historians. (Kee, Graham, et. al., 2009)

To sum up, the game attempts to provide a critical pedagogical model (Crocco, 2011) for teaching digital photography through engagement with older and newer forms of technology, historical archives, storytelling, and locative media in a mobile learning environment.

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# **Tug-of-War 2.0: A Digital Card Game**

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## **Introduction**

*Tug-of-War* is a networked card game designed to help youth develop fluency with fractions. One of the challenges of describing an educational game is to distinguish among the many aspects of learning that are important to learning designers. We will use the Seven Circumstances of Game-Based Learning framework (Arena, 2011) to communicate the learning aims of *Tug-of-War 2.0*. After applying the framework, we will discuss *Tug-of-War* in more detail, describing its history and the new features in this digital version.

## **The Seven Circumstances**

The seven-circumstances framework is a rhetorical device from ancient Greece. In this context, it can be used to help designers explicate the learning that occurs in and around an educational game.

**Who is the learner?** *Tug-of-War* is designed for upper-elementary students who have had lessons about fractions but have not achieved full fluency with the concepts.

**What is being learned?** Our game teaches and reinforces techniques for developing a “rational-number sense” (e.g., deciding whether  $\frac{7}{15}$  is bigger or smaller than .5) and performing fractional operations on whole numbers (“What is  $\frac{3}{4}$  of 8?”). To measure what was being learned, we used a paper assessment as a pre-/post-test containing questions directly relating to the aforementioned questions. We also recorded videos of students as they progress in the game, as well as observed help-seeking behaviors that children displayed while playing the game.

**When does the learning occur?** Students are introduced to and practice these techniques before and during gameplay.

**Where does the learning occur?** Although there are introductory videos to teach about game mechanics and basic fractions concepts, the learning occurs primarily in-game and in players’ conversations with their partners and opponents (gameplay is 2 vs. 2) about effective strategies.

**Why is the learner playing?** While our research was conducted mostly in classroom studies where gameplay was compulsory, students routinely asked whether they would get to play again next week, suggesting that they found the game to be fun. We hope for the game eventually to be voluntary and extracurricular.

**How does the learning occur?** The introductory videos present game mechanics and basic fractions concepts through direct instruction. Gameplay learning occurs primarily through situated exposure to fractional operations on whole numbers and comparisons among different representations of rational numbers: players have to solve such problems to arrange their teams for the tugs-of-war that end each round of play. These repeated opportunities to practice and build fluency come with corrective feedback from both peers and the computer, and they are supported by the use of virtual manipulatives to offset cognitive load (Martin, 2008). We used a paper assessment as a pre-/post-test containing questions directly relating to what we were hoping to measure, including items such as “What is  $\frac{1}{4}$  of 12?”. We also recorded videos of students as they progress in their learning of the game, as well as observed help-seeking behaviors that students displayed while playing the game. Lastly, we kept logs of the student’s activity as they play the game to track their progress with understanding the material.

**With what does the learning occur?** The digital version of *Tug-of-War*, a networked card game written in Java, was built by one of the authors over the span of a few months, based on a successful physical version of the game. For a more in-depth review of our measures and experimental design, see our earlier paper (Jiménez, Arena, and Acholonu, 2011).

## **The Tug-of-War Game**

Having explained how the learning fits into *Tug-Of-War*, we would like to now explain the game itself and its construction. Using an iterative design approach that started with paper prototypes, we have created a game that is relatively easy for children to learn, that they find enjoyable, and that has demonstrated success in helping them learn how to perform fractional operations on whole numbers.

The game is based on a series of fictional tug-of-war battles, in which students strategically play cards to increase their own strength or diminish their opponents' strength. The goal in each round of play is to choose cards that will create the biggest disparity in strength. To maximize disparities, students must compare fractional values and decide how best to play their cards. This digital version (see Figure 1) was based on an earlier paper version. Students who played the paper version demonstrated significant learning differences when compared to their counterparts on a statewide standardized test (Jiménez et al., 2011). The current digital version of *Tug-of-War* was developed as the successor to the earlier version; it, too, has been shown to help students build fluency with fractions (Acholonu et al., 2012).



**Figure 1:** A screenshot of the digital version of *Tug-Of-War*.

The digital version of *Tug-of-War* was implemented as a networked Java application, where players and their partners take turns choosing which cards to play against an opposing pair of students. The digital version takes much of the game management away from the students and serves as a moderator for rules that are logically but not conceptually important. Rather than immediately disallowing incorrect moves, the game provides the students with opportunities to make mistakes and learn from those mistakes. The computer version also has a *Show-me-how* button, which plays animation that reviews the strategy they should take to perform a fraction and walks them through all the steps. What *Tug-of-War* lacks in animations, flashy graphics, and 3D realism, it compensates for with measurable learning outcomes and design decisions that may foster discussion in the educational game landscape.

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# Creative Play and Social Impact

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## YourTurn! The Video-Game

“YourTurn! The Video-Game” (<http://yourturn.fm>) is a social network game about creating YouTube video mash-ups with other players made to foster social interaction, communication and the reflection of cultural identity among juveniles, primarily in Vienna, Austria, but the game has also been released internationally. YourTurn! is accessible on Facebook where players engage in ‘versus’ battles. Taking turns, they select short snippets of YouTube (music) videos, which they append to a mutual video mix. Playing against each other leads to a shared and creative result; a video mix made by two players who previously did not know each other. Thus YourTurn! brings together youth of different ethnicity, gender and place of residence who normally would not be in contact with one another. Thereby, music acts as identity-related tie (Solomon 2009). The sustained yield of the forming relationships is supported by a series of events and workshops.



Figure 1: The start page of YourTurn!, which shows the most popular video mixes and opportunities to contribute.

A pre-study in Vienna, Austria and insights on media use and everyday social interaction shaped the design of the game. YourTurn! builds on core mechanics which enable it to become a playful means of communication, transform competitive play into cooperative play, facilitate a shared reflection of culture and identity and train media literacy.

## Background Information

Preceding studies show that youth in Vienna tend to segregate into closed ethnic groups (Weiss, 2007; Götzenbucker & Franz, 2010; Thomas & Crul, 2007). To answer the central research question

*>Can an online social music game allow Viennese teenagers to change their understanding of cultural diversity in order to overcome cultural and ethnical boundaries?<* a game is designed, developed and evaluated within a multidisciplinary academic setting (Kayali et al. 2011) involving partners from social and political sciences, informatics, game research and game industry. The game builds on 51 personal interviews conducted between March and June 2011 with 27 male and 24 female teenagers living in Vienna. The results of this research helped identify touch points for the game intervention and provided starting points for drafting the game's design. The interviews showed that an overwhelming majority uses Facebook and YouTube on a regular basis. It also became clear that these web services are not only used daily but that they have become an essential means for social interaction and media consumption. Hence we decided to use communication through media especially through music videos to be the core of our design.

The study led us to use the following core mechanics, which shall foster social impact through creative play:

- The back and forth of cutting and appending videos becomes a playful means of communication, fosters togetherness and helps expand social boundaries.
- Players engage in a VS battle but in the end they create something together. The transformation of competitive play into cooperative play is a crucial step towards bringing participating youth closer to one another and supporting inter-ethnicity in their social networks.
- Videos are created based on a topic and for example allow players to reflect their place of residence together. Taking turns players negotiate meaning by submitting adequate video responses. The free association style of play enables shared cultural reflection and furthers the process of acculturation (Berry, 2001).
- Other topics allow players to express their identity. Doing this together fosters intercultural understanding. Striving for game goals together ideally overrides the cultural restrictions present in everyday life.
- Players gain media literacy. Finding a matching clip means learning to reflect communication, aesthetics and context.

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# **Quandary: Building Capability in Ethical Decision Making**

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**Abstract:** Children, particularly middle-schoolers, need opportunities to engage with ethical issues and develop skills to deal with them. These skills, including perspective-taking and ethical decision-making, will better prepare them when they encounter difficult issues in their day-to-day lives. The Learning Games Network, with funding from a private family foundation, is working with experts from Tufts University to create a game that addresses these challenges. The goal of the game is to provide players with foundational skills in age-appropriate ethical thinking. Players are encouraged to recognize ethical issues and increase their competence in dealing with them, helping empower them to act ethically in their own lives. *Quandary* reflects real-world issues where there is no easy answer. The game is in production and a beta version will be available to play during the GLS 8.0.

## **A unique game for young learners**

The Learning Games Network (LGN) is developing a game for young learners to consider the subtleties of ethics and build their own moral reasoning capability. *Quandary* is funded by a private family foundation and developed with experts from Tufts University and technical producers at FableVision.

## **The need for moral guidance**

Research has shown that pre-teens and teens are in need of moral guidance. In 2010, the Josephson Institute's Center for Youth Ethics conducted a nationwide survey of more than 40,000 American high school students. The study found entrenched habits of stealing, lying, and cheating. Despite their own responses detailing their dishonest habits, 92% of students said that they "were satisfied with their personal ethics and character." According to the Josephson report, "the gap between what students believe and their actions does not bode well for future generations." Though some excellent programs have been created by non-profit organizations, middle schools and high schools are generally failing to provide moral instruction to adolescents when they need it most. Clearly, pre-teens and teens are in need of opportunities to engage with ethical issues and develop the skills to deal with them so that they will be better prepared when they encounter ethical issues in their day-to-day lives.

## **Market niche**

There is a gap in the market for games that are specifically designed to promote moral development. Although many games have design elements that engage players in perspective-taking, decision-making and conflict resolution—all foundational skills for moral development—we know of no game purposely developed, in both its design and content, to promote these skills and competencies.

## **Game design challenges**

The following design challenges have been identified:

- How do you design an engaging learning game that encourages children to recognize ethical issues, and increases their competence in dealing with ethical issues?
- How do you create a playful space where learners can investigate how a complex community with different perspectives reacts to dilemmas in their world?
- And how do you facilitate the all-important discussions that such a game inspires, fostering reflection on the decision-making process?

## **Game approach**

Using age-appropriate scenarios, the game introduces players to the idea that members of a community have different needs and different viewpoints. The player must investigate the varying perspectives within a community facing a tough situation. They build their competency in making ethical decisions by learning to see other people's points of view, separating fact from opinion, and filtering emotion from reasoning. The game is about ways of approaching ethical issues rather than telling players what to think.



*Figure 1: Initial artwork from Quandary.*

The game engine allows for future scenarios to be plugged-in, including the potential for content generated by both students and facilitators. A set of support materials will facilitate players in discussing and reflecting, therefore solidifying their understanding.

## **Results and discussion**

The game is in production and a beta version will be available to play during the GLS 8.0 Educational Game Arcade. Results and feedback from play-testing will also be available. Play sessions will offer an opportunity to reflect and discuss the effectiveness of this unique approach.

## **Atlantis Remixed: Advancing Research into Sustainable Designs**

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### **Design**

*Atlantis Remixed* is a 3D multi-user education platform that immerses children, ages 9-16, in educational play. *Atlantis Remixed* is the result of over a decade of research with *Quest Atlantis*. It synthesizes the theory of transformational play (Barab, Gresalfi, & Ingram-Goble, 2010), lessons learned through years of implementation inside of hundreds of classrooms, and modern video game design standards to create an educational product that can offer a sustainable and transformative impact on education systems internationally.

*Atlantis Remixed* allows students to investigate fully realized virtual worlds where they participate in educational adventures and narratives. Within these worlds they can create unique personas, chat with other users, interview characters, observe and manipulate systems that respond to their choices, and even create entirely new adventures and worlds. The game invites students into worlds where they act as active protagonists in narratives that situate them to acquire and execute expertise in curricular subjects—knowledge that when combined with social awareness can be used to cause significant change in the virtual spaces. By doing so, students strengthen their awareness of the connection between their identity, the knowledge they learn, and the way in which that knowledge can be used to shape the world around them (Barab, Pettyjohn, Gresalfi, Volk, & Solomou, 2011).



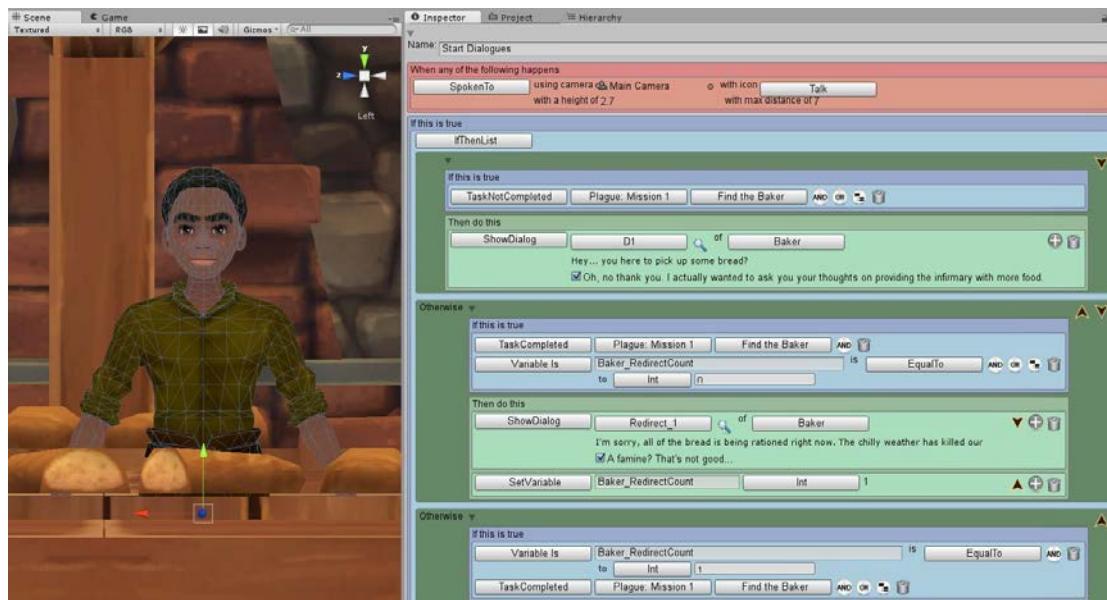
### **Implementation**

*Atlantis Remixed* utilizes the Unity 3D game engine to allow the latest developments in the cognitive and learning sciences to be integrated into a video game that contains industry competitive production values. Professionals from the gaming industry were brought together to work with curriculum experts with the aim of creating an experience that is visually engrossing, mechanically fluid, and academically rigorous.

One example of the curricular experiences is a language arts unit that teaches persuasive writing skills. Students are positioned as investigating reporters who must write an argumentative essay for a newspaper that will determine the fate of a village. The students must interview townsfolk and analyze complex textual sources in order to accumulate evidence for their argument. The choices the students make with each interaction with a character is preserved and reflected in that character's willingness to give the student the information they seek. While out collecting evidence, the students continually experiment with the connections between their thesis, reasons, and supporting evidence.



In addition to developing curriculum units for mathematics, science, and language arts, development has focused on iterating the design tools with the aim of releasing a powerful but simple to use toolset for user-generated content. These tools scaffold narrative construction as a motivational foundation upon which logical structures and game programming can be built. Engagement with these construction tools has the potential to be an educationally rich experience (Games, 2009). Eventually, players will earn access to increasingly complex and rich tools that they can use to modify and create the kind of spaces and narratives they experienced in their classroom.



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## **Past Present: A 3D Role Playing Game to Teach Social History**

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### **Experience History from the Inside Out...**

*Past/Present* is an irreverent, surprising, and fresh approach to teaching social history to secondary schoolers created by the Center for New American Media and Muzzy Lane Software, Inc. *Past/Present* is an immersive digital video game where players live the lives of Americans from eras past. Imagine a learning experience where students are thrust into the everyday hustle and bustle of a century or two ago. They might find themselves enslaved in an antebellum town, or caught up in a strike in a Massachusetts textile mill, or riding the rails in the Depression. Students will need to have all their wits about them to survive in these unfamiliar environments.

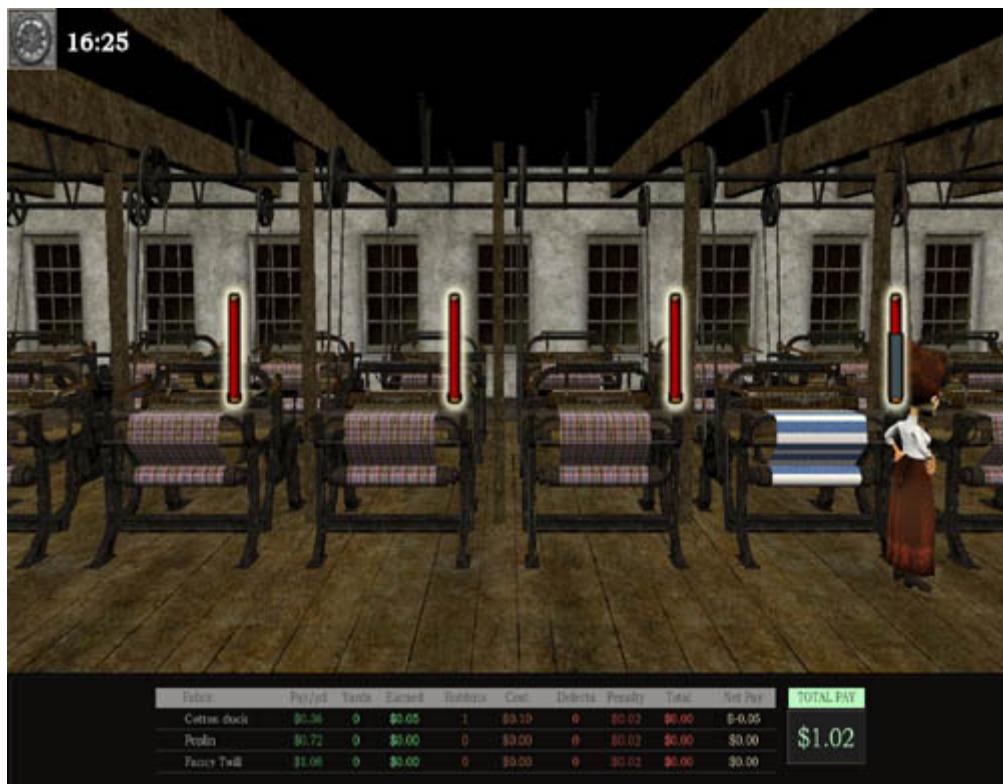
This excitement is at the heart of *Past/Present*, a suite of immersive 3D first-person computer games (formerly known as *American Dynasties*) that conveys the vibrancy of American history to secondary-school students. Each game portrays an important moment in U.S. history—such as the fight against slavery in 1855, the riots around the Stamp Act in 1765, or New England labor unrest of the early 1900s—and allows players to assume the roles of a diverse cast of characters, each representing someone from a different economic, racial or ethnic background living at that time.

The now completed first *Past/Present* Game Era, is an exciting adventure set in 1906 in the fictional New England mill town of Eureka Falls. Players will have a choice of playing one of two avatars: Anna Caruso, a young Italian-American weaver who works at the Boylston Mills and has to decide where she stands when labor conflict comes to town, and Walter Armbruster, a young manager in the same mill who has to decide the best way to handle the labor disruption and keep the mill running.

In each role, players face challenges and decisions that their character might have faced, and see the consequences. As they journey through a day in their character's life, players will face difficult choices, moments of joy and sadness, exciting adventures, and plenty of colorful incidental characters to keep them company

*Past/Present* is tightly aligned with secondary school state and national history standards and has been developed with support from a grant from the Corporation for Public Broadcasting and the National Endowment for the Humanities.





# Exploring a Studio Critique Model for STEM Evaluation

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**Abstract:** Through the principles of “leveling up” and “epic win,” gaming builds assessment into the process of learning (Gee, 2003). Gaming provides a model to evaluate the user’s quest for knowledge as well as the synthesis of material beyond the accumulation of time on task. These ideas of progression parallel the non-linear aspects of visual accomplishment that studio educators seek to quantify. This paper seeks to explore the connections between game theory, studio/lab practice, and the ways that educators are framing the component aspects of a complex learning experience. The goal will be to propose methods of formal evaluation and rubric generation to facilitate accountability for these highly complex learning environments.

In her paper, *Semiotic Pedagogy and Art Education*, (1995) Deborah L. Smith-Shank suggests that the current teaching dynamic “...assumes that there is a correct body of knowledge for a teacher to communicate to students. These models assume a hierarchical architecture of facts and ideas with higher forms of knowing built through some concatenation of simpler forms. In order to move away from the dominant hierarchical model, it is necessary to develop an entirely different framework.” The notion of “student as receiver of information” needs to evolve to “student as author of understanding”.

## Design Thinking and The Scientific Process

Recent studies indicate that complex and immersive games can contribute significantly to student understanding of difficult concepts in the sciences because they entertain and motivate students to engage in complex thinking and problem solving. Applying modern game paradigms to STEM learning promotes several learning principles, including the achievement principle where players earn intrinsic rewards from learning, the material intelligence principle where they use objects in their reasoning efforts, and the transfer principle where they are given multiple opportunities for practice and applying learning to novel contexts (Gee, 2003). In a comparative study, Barab et al., (2009) found an immersive gaming experience to produce significantly higher learning outcomes than other science learning experiences.

## Virtual Biology in a Box

The proposed *VBioBox* game series leverages the Biology in a Box K-12 outreach project’s mission of understanding STEM through scientific inquiry/practice to a global audience. Under this learning strand project we specifically will test the idea that an immersive video gaming experience that employs successful gaming paradigms and is deployed online (apps and web), can successfully engage students in learning STEM subjects and gain their interest in STEM fields. We have chosen evolution by natural selection as the theme for our first game entitled *Epoch Traveler Challenge* (ETC), because this difficult concept provides a unifying framework to understanding and integrating the immense body of knowledge available on biological systems. ETC is designed to immerse students in STEM (science, technology, engineering, and mathematics) educational experiences where they will function as biologists gaining the practices, tool sets, and understanding of concepts needed to meet single player virtual world traveling and multi-player shark design challenges.

This project represents a quantitative examination of the potential benefits of edutainment to student learning and perception of STEM disciplines. Can immersion in a role-playing game infuse in students an understanding of the process of science, draw their interest towards STEM fields and, in this particular ETC game, provide them a deep understanding of the factors underlying biodiversity? Role-playing (Riechert et al. 2011) allows students to explore evolutionary processes for themselves. Including the mathematical, physical science, and geological underpinnings of biology in our ETC and future *VBioBox* games illustrates to the students the inherent quantitative nature of biology and allows them to make connections between concepts taught in biology and other STEM courses. In evaluating this game, we will examine the relationship between student progress through the game environment and their corresponding gain in knowledge of concepts and practices achieved during the course of play. We are most interested in whether a student’s level of understanding of ideas and practices they are exposed to makes the progression beyond *knowing that* to *knowing how* and from

being able to explain (*declarative knowledge*) to being able to actually do (*procedural knowledge*) (Schaffer, 2006).

The *VBioBox* game, targeted to high school students, fosters the formulation and testing of hypotheses (reflectivity; scientific inquiry; and trial-and-error learning), based on available data and observations (exploratory learning), promoting deep understanding through agency (Murray, 1997). The game features a seamless integration of *iterative* (Salen and Zimmerman, 2004) and *incremental* (Schell, 2008) design, implementing meaningful progressive steps to success. In fact, players can reformulate hypotheses applying new understanding and knowledge acquired through in-game challenges tailored to their level of expertise, made visible through continuous assessment and feedback. The goal is to offer the appropriate amount of challenge to the players, stimulating their curiosity and promoting active learning in their Zone of Proximal Development (Vygotsky, 1978).

The game, as opposed to a traditional approach of *learning science*, is a *doing science* experience. In fact, it puts the player in the role of an apprentice in a science lab, whose ultimate mission is to ensure survival of the human race over time. The knowledge acquired through the game (e.g., collecting and analyzing fossils) constitutes *evolutionary building blocks* that will be used to create the “fittest” shark, and, finally, acquire knowledge that will benefit mankind. This process stimulates the transfer of scientific knowledge across evolutionary domains (from fossils to sharks to human beings), advancing scientific thinking and promoting a comprehensive approach to STEM learning.

This learning trajectory requires a form of assessment capable of identifying and valuing, rather than measuring, the efforts and progress of each player. In this context, the *VBioBox* research team is working on two entwined assessment features: 1) a *rubric*, considering the multifaceted dimensions described above, in relation to the subject (science/biology) and the targeted audience (high school students); 2) a *representational model*, which includes visual and graphic elements to represent the learning process, and to communicate and situate the progress to both teachers and students, in a meaningful way (rather than providing letters, numbers, or general comments). Through this approach, the game makes the integrated assessment relevant and visible, in order to advance the understanding about student’s knowledge, attitudes, and perceptions toward biology and STEM disciplines.

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## **Micropresentations**



# Becoming an Expert Boardgamer: A Quantitative Exploration

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**Abstract:** Strategic board games can be the site of complex computational thinking, but little is known about how expert boardgamers develop expertise. In this paper, we investigate expert boardgamers by mining public data from BoardGameGeek to see how buying patterns change over time. We then explore the implications for learning complex content.

## Introduction

Strategic board games (or "eurogames") have been growing steadily as a game genre in both Europe and North America recently. Where these games were vanishingly rare only ten years ago, now they are regularly featured in the New York Times (Irfan, 2011). These games have a couple of interesting and distinctive features that video games generally lack: they require precision and careful planning on the part of the players, they often require collaborative or cooperative strategizing, and they force the players themselves to act as the "Game manager" which can require complex logic. Indeed, Berland & Lee (2011) showed that strategic board games can be the site of complex computational thinking. However, board games are a niche hobby, and, as such, there have not been many recent studies on board gamers as a group. In this paper, we investigate expert boardgamers by mining public data from BoardGameGeek ("BGG", n.d.) to see how buying patterns change over time. We then explore the implications for learning complex content.

## Methods

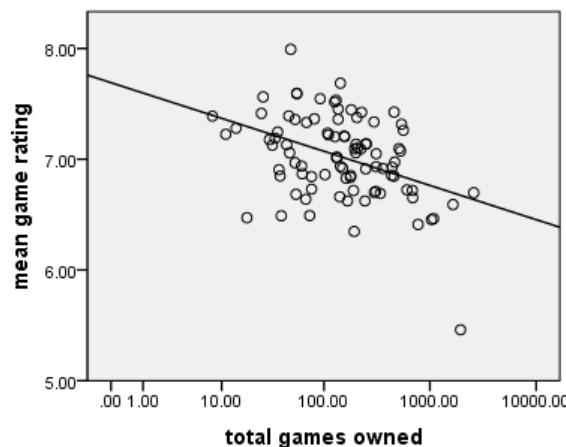
### Data collection

The sample consisted of 90 (ninety) expert boardgamers' public profiles on BGG. The sample was selected randomly, consisting of the first 90 usernames (sorted alphabetically) that showed 'ownership' of most popular 'hardcore board game' as selected by the BGG community at the time of submission; the game (*Twilight Struggle*) requires 3 hours to play and prior expertise with strategic board games. The usernames in the sample averaged more than 100 strategic board games owned. The first ninety usernames did not appear to show any obvious bias, as most of the usernames were clearly pseudonymous (e.g., alakazam). Each username was associated with a profile showing both a list of games owned and the date on which each game was marked as owned. Although this is not necessarily equivalent to date of purchase for each game by that username, it provides a rough estimate of that date, as the BGG community rewards keeping collections current with badges and other incentives (BGG, n.d.).

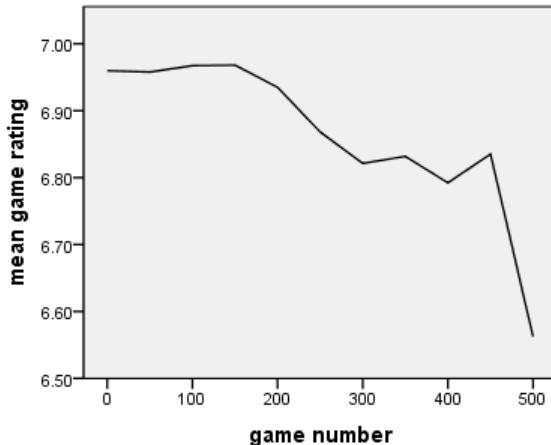
### Measures

*Total games owned* is a count of the number of games marked as 'owned' in a username's profile. *Date marked* is the date that each game in a username's profile was marked as owned. *Game rating* is the rating of that game as a weighted mean of the hundreds of thousands of raters in the BGG community. This information is provided along with each game's description in each username's profile. The *mean game rating* for a username is the average rating of all of the games marked as owned. *Game number* describes the order in which the games were marked as owned for each username. For example, the first game added would be 1, the second game added would be marked as 2, and so on.

## Results



**Figure 15: Collection size and game quality**



**Figure 16: Average game ratings over time**

Figure 1 shows the relationship between *total games owned* and *mean game rating* of the users' game collection. The relationship shows a strong and significant negative correlation ( $n=90$ ,  $p<0.01$ ). Figure 2 shows the relationship between *game number* and *mean game rating* over time of the users' game collection. This trends significantly negative ( $n=90$ ,  $p<0.01$ ), as well. Note that the Figure 2 is cut off at 500, as the data become significantly sparser (as can be seen in Figure 1).

## Discussion

The data show that, as gamers owned more games, the games that they bought decreased in 'quality' as judged by the community rating. This could variously imply:

1. *The shame hypothesis*: The players were so ashamed of the terrible games that they had purchased that they waited until recently to add them.
2. *The game addict hypothesis*: The players could find no more 'good games' to buy and wished to keep buying games.
3. *The acquired taste hypothesis*: The players' interests became more specific over time, finding value in specific facets of otherwise low quality games. The players had learned enough to be able to play games that other players found difficult.

The 'shame' hypothesis is included to illustrate that these data are purely self-report and, as such, relatively unreliable. The findings of this study should not be considered broadly generalizable; they are preliminary and exploratory. The 'game addict' hypothesis illustrates, in part, the real issue of sampling bias. Indeed, there are only a finite number of extremely well reviewed games, and owners of 1000 or more games will necessarily include many games that are of low rating. It is also likely that people with a very large number of games will have purchased the most popular ones early. That said, it seems unlikely that the sample usernames buy games simply for the thrill of buying games, though that might represent a dream of the publishers. This possibility provides some information, but it is mostly unhelpful. The 'acquired taste' hypothesis seems the most plausible overall. At one level, it appears obvious: niche products are often an acquired taste (e.g., Marmite). However, it implies both that one can learn to enjoy playing very hard, generally un-fun games and that the people who enjoy those games did not start out that way.

This study suggests that even the most expert boardgamers took thousands of hours of training to enjoy the most difficult games, and that they kept on buying more and more unpopular, difficult games over time. In short: expert board gaming takes work.

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# Game Design and Computer Programming in the General Education Classroom

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**Abstract:** In Fall 2011, we taught a course entitled “Writing and the Electronic Literary,” an English course that fulfills a University of Wisconsin-Madison general education requirement. The course included a project in which students, most of whom had never written a computer program, used the Inform7 design system to build works of Interactive Fiction (IF). In this presentation, we briefly describe our approach to teaching the course and make a two-fold argument: 1) the general education classroom offers a useful space in which students can connect the practice of writing with the practice of computer programming; 2) games are the ideal medium by which we can help students to make that connection.

## Introduction

In Fall 2011, we taught a course entitled “Writing and the Electronic Literary” in the English department at the University of Wisconsin-Madison in which students interacted with and created digital objects. We relied upon Katherine Hayles’ argument that the term “electronic literature” was too narrow and that “the literary” offers a more expansive container for discussing a broad range of related artifacts such as digital art, games, digital poetry, and hypertext fiction (2008). This was a writing class designed to fulfill a general education communications requirement, and this meant that students arrived in the class from a number of different backgrounds. Such a diverse population—students in our class came from seven different colleges—is the norm in general education writing classes, and it presents various challenges.

Students arrive in such classrooms with varying sets of skills and expectations, and these challenges become even more pronounced when teaching computer programming in a writing classroom. However, we see the general education writing classrooms as a key space of opportunity for those of us trying to bring programming and software design to broader audiences. Further, we see game design as a particularly useful way to link together the concerns of computer programming and writing studies.

## Inform7

We broke the course into three units: electronic literature, interactive fiction, and videogames. The first unit focused on hypertext fiction and other genres of electronic literature, and the third unit asked students to conduct a close analysis of a videogame while reading Ian Bogost’s *How To Do Things With Videogames* (2011). It is the second unit on interactive fiction (IF) that we’d like to focus on in this micropresentation. During that unit, we read Nick Montfort’s *Twisty Little Passages* (2005), a book that offers both a history of IF and a theoretical account of it, and played through some text adventure games (*Adventure* and *Zork*, for instance) in order to gain appreciation for the genre and its conventions. Our hope was that playing and reading about IF would give students ideas for their own games, and we encouraged students to make references to other works of IF in their games (a common practice in the IF community). In encouraging this practice, we were teaching students the same citational practices that they learn in other writing courses.

Students authored works of IF using Inform7, a language and development platform created by Graham Nelson specifically for writing IF. It is well designed overall and has many useful features. For our purposes, its most interesting characteristic is that programs are written almost entirely in natural language. For example, if the programmer wants to create a room called “Kitchen” which contains two objects, a stove and a refrigerator, s/he need only write:

*The Kitchen is a room. A stove and a refrigerator are in the Kitchen.*

The programmer’s job is simply to describe the setting, characters, and interactions using English sentences. Once the stage has been set, an interpreter spits out a fully functional piece of interactive fiction at the click of a button. The greatest strength of this approach is that it is completely unintimidating to a casual observer. The immediate reaction to reading a program written in Inform is

usually: “I could write that.” Students quickly realize it might not be so simple; users of Inform7 still need to learn rules and syntax. Still, Inform carves a middle ground between writing English sentences and having to learn programming syntax. The result is a platform that looks like English (which avoids intimidating and alienating novice programmers), but is robust enough to allow for complex works of IF.

We tasked the students in our class with creating works of IF that used the unique features of the medium to communicate an idea and with constructing a meaningful experience for the interactor. This required them to understand that IF offers different affordances than traditional writing. The students created a number of interesting games; one particularly strong project was a game called *Bully Be Gone*, created by Chelsie Zitzsperger and Michael Hagerty (1). In this game, the player must navigate through a school in search of a bully. As the player goes about performing various actions typically associated with adventure games—picking up items that might not belong to the player, attacking various NPCs—s/he gradually begins to realize that s/he is, in fact, the bully. From this realization, the player must retrace steps through the school, righting the various wrongs s/he perpetrated earlier in the game.

The game’s real strength is that it implicates the player in the process of bullying, forcing the player into the role of aggressor. This makes the player reflect on their own actions rather than those of some hypothetical third party. As Ian Bogost argues in *Persuasive Games* (2007), this is a powerful rhetorical technique. While a good writer, speaker, or filmmaker can make the audience feel some of a character’s emotions, the procedural rhetorics of a videogame allow an author to put the audience into a character’s shoes.

In learning to use Inform7, students learn many skills that would be important in a computer science classroom, from if-statements, to the process of developing and debugging, to beginning to “think” like the computer. Most importantly for the purposes of this presentation, students are afforded the opportunity to create games that sit somewhere in between the texts that they are accustomed to reading or writing in a general education communications course and the computer programs that they would author in a computer science course. Game design bridges these two forms of writing, offering students a framework for understanding how computer programs can be used to communicate ideas in novel ways.

## Conclusions

General education continues the tradition of a liberal arts education within institutions of higher education that are fragmented into specialized fields and majors. One hope is that general education courses provide students with the opportunity to step outside the narrow focus of their degree program. Students in classes like ours are asked to learn communication skills in various genres—they produce a great deal of writing and do oral presentations. However, our course conceived of communication even more broadly by teaching computer programming alongside other modes of communication.

As we have argued, game design is an ideal way to expand students’ definition of communication. Our course offered game design as a way for students to think of the ways in which computer programming and writing are similar. Beyond this, we hope that such a course makes a grand gesture by considering computer programming as part of a liberal arts education. The fields of game studies and game design can and should be a part of this grand gesture.

## Endnotes

- (1) All the games created by students in this class, including *Bully Be Gone*, are available at: [http://courses.jamesbrownjr.net/interactive\\_fiction](http://courses.jamesbrownjr.net/interactive_fiction)

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## “How Does The Story End?”

### The Role of Unfinished Games in Supporting Kids’ Learning

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**Abstract:** Formative research suggests that there is great potential for using incomplete games as a tool for extending learning in the regular school classroom, in after-school clubs, and in field trip experiences. By placing deliberately unfinished games in front of pre-teen and early teen players and inviting them to offer constructive suggestions for the game’s completion, students have structured opportunities to reflect on and deepen their understanding of relevant academic content and game mechanics. The paper cites specific examples from recent practice and offers suggestions as to the attributes needed by effective program leaders to make the best use of these games.

Generally, the game studies literature suggests that having a clearly defined and attainable “win state” is part of good game design. That is to say, it is important for the player to know when they have completed the challenge successfully. Ideally, there is also good feedback along the way so that the player knows how well he or she is progressing. For most game situations, these are no doubt important considerations. However, there is an alternative worth considering: *Is there value in having an unfinished game space?* This paper and presentation will advance the counterintuitive notion that there is a great deal of productive learning that can happen when the game doesn’t play out to a win state. Rather, it is the very ambiguity of outcomes and the potential for “something more” that can spark the best learning. Without the computer sorting out winners and losers, students can more readily be guided into productive discussion based on what they experienced.

To investigate this potential use of games in education, the author has created several “games in progress” for use with pre-teen learners in field study programs at an environmental education center and in after-school programs in the community. These include an augmented reality game investigating which among several species is the most important part of the forest, and agent-based modeling games investigating pollinator populations and the role of bioretention in managing floodplains. The goal in these is not to provide a complete game experience, but rather to engage the kids in an interesting space that sparks discussion. The resolution comes in the reflection that follows the game immersion experience.

For example, in the pollinator game, students start by deciding how many pollinators there should be in the model ecosystem. As the game begins, the player moves into observer mode as the action unfolds on the screen. In many ways this is a “god game” where the player’s interventions are limited: You create the conditions and watch what happens. The pollinators go about their business in pre-programmed action paths driven by a degree of randomness, pollinating or not as they are able. As plants are pollinated, they reproduce and thereby enhance the ecosystem. At a simplistic level, students come to understand that more pollinators leads to more pollination and thus more plant growth. The real educational value, however, comes from the post-game discussion in which players are led to consider critically various aspects of the game. Prompted by the instructor to offer ideas of “what would help me to finish this game,” students have a chance to demonstrate their understanding (or misunderstanding) of ecosystem dynamics. Do the pollinators seem to favor some plants over others? (Based on what you know about ecology, should they?) Is the random movement of the pollinator realistic? How would the game be different if the pollinators engaged in a seeking behavior? Should there be limits to how much the plants can grow?

As provocative questions are raised, the game dynamics can be investigated by looking at the underlying programming blocks. Since the software used in designing these games makes the programming transparent, students can see how the game they just played unfolds. Depending on the time available, quick modifications can be made by the instructor or by the students, and the game replayed with the new rules. The iterative play – discuss – modify – play cycle sparks a higher level of thinking about ecosystem dynamics than are possible in a textbook-driven environment where facts are the coin of the realm. Instead, understanding of interactions and contingencies becomes essential. Arguably, these discussions around an imperfect game space are richer than would happen in a more polished, scientifically validated environment. With “holes” in the game and an invitation to help complete the game, students attempt to draw on what they know to fill in the gaps. Or, the game

raises questions that prompt further reflection and investigation. In the author's experience, students sorted into winners and losers are less likely to engage in such focused reflection.

To be clear, the argument here extends only to specific learning contexts. As commercial, off-the shelf games played individually or among peers for recreation, they would be a first-order flop. Games for those audiences should follow game norms for win-state and appropriate levels of feedback. But, there is great potential here to use incomplete designs to extend the use of games during the school day, in after-school settings such as environmental clubs, and as a part of field trip programs offered by science and cultural institutions.

Students in these settings can be supported by a guide with a reasonable degree of expertise both in the academic content area and in the mechanics of the game's underlying design. To be successful, this person needs enough pedagogic content knowledge (Shulman, 1986; AACTE Committee on Innovation and Technology, 2008) to know which areas are most fruitful for discussion, and enough understanding of the software to quickly modify the model to allow a re-run. Or—in contexts where there is enough time to do so—having the students modify the model directly might offer even more learning potential. A skilled leader will need to exercise judgment about how quickly to turn the students loose on a re-design vs. making the modification to one version of the game projected on a large screen for the group. There is a very real trade-off here between giving students more ownership of the game through direct manipulation of the software and maintaining focus on the question at hand. As with many other issues in structured learning environments, the time available drives many decisions. In the author's experience, short experiences allow a quick "Let's all change this..." level of manipulation, whereas longer multi-session programs allow the time to support students in their own manipulation of the underlying program, which in turn enables students to explore more fundamental re-workings of the game dynamics.

This effort remains a work in progress, but to date the results have shown promise and warrant further work in the design of the games and in developing protocols for supporting effective project leaders.

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# Art Games: Creating Video Games Within an Art Curriculum

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**Abstract:** As an influential form of digital visual culture, video games offer art educators numerous pedagogical opportunities. My paper intends to show how making video games through an art-based curriculum provide young people one of those opportunities.

Many supporters of games in education discuss learning from playing games, but fewer studies focus on the creative learning from making games. Research focusing on game creation primarily connects game development to Science, Technology, Engineering, and Math (STEM) subjects. However these studies do not focus on the creative, metaphoric, interactive components of game creation. Yet for many of the 20th century art movements, game practices were foundational to developing an aesthetic that rejected standards, practices, and systems within art.

From my current research, I provide examples of students learning about complexity thinking by producing video games as part of a 4-8th grade art-based curriculum.

## Games as Art Making

While few research studies on the value of making games as art projects exist (Keifer-Boyd, 2005; Gill, 2009; Peppler, 2010), currently, research studies in art education have not looked at the impact of making video games with students. Studies in disciplines outside of art education have concentrated on whether or not student-made games were efficient and effective to teaching math (Kafai, 1995) language (Robertson & Good, 2005), or computer science (Seif El Nasr & Smith, 2006; Dalal, Dalal, Kak, Antonenko, & Stansberry, 2009). However these studies were not focused on the creative, metaphoric, interactive components of game creation.

Games, defined in this study as structured play, provided the foundation for many of the works from 20th century art movements, such as Dadaism, Surrealism, Situationism, and Fluxus, embodied issues of complexity in their use of game making methods by exploring and exposing rules of political, economic, and environmental systems (Flanagan, 2009). By contextualizing games within the historical practices of artists throughout the 20th century and digital media practices of the 21st century, game creation can be understood as credible art content for parents, school administrators and the contemporary art classroom.

My study included four classes of students, ages 8-13, learning concepts and methods of game development including physical, tabletop, and video games over a 5-day period in a camp-styled course. This research relies on using complexity theory as an umbrella concept, designed to include, combine, and elaborate on the insights of any and all relevant domains of inquiry, such as economics, physics, and biology (Sumara & Davis, 2009). By making games as a method to approach concepts of complexity, the finite scope of the game creator's abilities and emergent game behavior are exposed to reveal how complex and interconnected our daily lives are.

Students in this study learned video game programming through the visual interface of Game Maker, using a curriculum developed around the language of move, avoid, release, and contact (MARC) (1). The abstracted concepts of MARC framed scenarios that can have social, philosophical, theoretical, political, or psychological implications for students (2). Considered as metaphors for procedural options in different types of systems, MARC is theorized to connect students to video game unit operations as a way to develop artistic metaphors for the systems of everyday lives.

## Sam: The Unit Operations of MARC Everywhere

Conducting interviews 3-months after the course, Sam, age 10, saw a connection between the complicated 3-D games he plays and the game he made in the course:

I have these 3-D video games that are very large complicated worlds, but I still try to figure out how the game works, and if the designers used Game Maker, how to get the game to work ... I actually thought once that the world could be like a game because if somebody made it a game and if you touched your desk, or you touch a

table, it would need to be solid to move it ... But that's impossible to make a game like that because it would take like a million years.

Sam immediately established the difference between games as being simple and complicated, describing the complexity of the vast worlds of his 3-D games. Sam noted the games he plays have many types of objects interacting in complex ways, a programmable task that would be difficult to recreate in all the ways we interact in daily life.

### **Gina: MARC Important to Gameplay**

Learning the how to make games and using the MARC concepts, Gina age 11, began seeing games as a maker, glimpsing below the playing surface to understand how video games work with interdisciplinary knowledge:

When the course was over, I went home and would talk to my parents about what we were doing and try to explain to them, how you put actions and objects in the game...us(ing) actual examples...I would pick up a pencil then I would be contacting it. Then if you released the pencil...you are dropping it. If you catch something, that would be contacting it, and all this different stuff ... if this was happening in real life and if they were throwing this, then it would be releasing it and if I were catching it, then I would be contacting it.

Thinking about MARC in the games they played, students considered how computational systems of video games work. Students, like Gina, understood that MARC actions work simultaneously, acting as connected parts of a system to make the game function properly.

During the course, students continued to use the basic concepts of MARC to make personal decisions to change the forms of complexity in their games. When students moved beyond the introductory tutorial, they changed their game systems, determining the level of complexity by creating new rules, game objects, and behaviors. Designing pedagogical strategies in a game development curriculum that explores complexity encourages students to expand their knowledge base. Applying the open metaphors of MARC to art-based game making, the course content demonstrates the interconnection of academic subjects and deeper understanding of cause and effect to situations in life. By making games in the traditionally less rigid, creative space of the art classroom, gives students the freedom to play and learn by taking risks or failing.

## **Conclusion**

It can be explained to parents that this game-based art pedagogy honors and values the history of art, inspired by the game practices of the Dadaists, Surrealists, Fluxus, and Situationists. Students-made games can be considered a form of action research, an iterative process of theorizing, testing, and receiving feedback to the game systems they created. In this iterative process of making, students problematize and problem-solve complex and emergent ideas.

## **Endnotes**

- (1) I developed MARC as a way to abstract the actions of many video games into a language showing commonalities across video game genres (shooter, action-adventure, role-playing, strategy, etc.) and describes events in everyday life within a game context.
- (2) **Social:** *Making Friends* – move (moving towards a desirable person), avoid (getting away from undesirable people), release (removing friends from social circles), contact (take actions to becoming friends).  
**Philosophical:** *Aesthetics* – move (steer towards aesthetic preference), avoid (steer away from aesthetic pitfalls), release (masking aesthetic mistakes), contact (making aesthetic choices).  
**Theoretical:** *Semiotics* – move (grab signs that have multiple meanings), avoid (strengthening established meanings), release (send signs to the vocabulary pool), contact (combine signs with other signs to create new meanings or remove meanings).  
**Political:** *Universal Healthcare* – move (getting the health bill passed), avoid (losing votes), release (messages to the public promoting the bill), contact (persuade and acquiring votes).  
**Psychological:** *Anxiety in public speaking* – move (give speech in front of the class), avoid (poor inflection, students laughing), release (saying words at the proper time), contact (making eye contact, using inflection).

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# Epic Fail: Why is it ok to fail in Videogames?

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**Abstract:** Failure, the state or condition of not meeting a desirable or intended objective, is a promising area of study that could give insight into learning and allow for the creation of more effective learning spaces. Unfortunately, failure has transformed from simply not succeeding to something that determines future opportunities. In order to leverage failure, one must understand not only the metacognitive processes that are taking place, but also the learners' interpretations of failure and how those interpretations might impact their future performance.

## Epic Fail

Most people avoid failure. In an age of constant assessment, failure has transformed from simply the state or condition of not meeting a desirable or intended objective, to something that determines the opportunities available to students. Failure becomes a label by which a student's mental faculties are assessed. In its most malicious form, a failure can even manifest itself as a learning disability. At this point it has devastating effects on how the student views themselves, and how society views the student (McDermott, Goldman, & Varenne, 2006). With so much at stake it is no surprise that students do not wish to fail.

Unhelpful, and often negative, feedback may be a reason that students avoid failure in the classroom. In a 1984 study, Harriet D. Semke concluded that feedback consisting only of whether there was an error, was interpreted as negative and unhelpful by students, even when the correct forms were supplied (Semke, 1984). Modern day classrooms still mark incorrect answers without supplying constructive feedback, a critical component that allows a student to progress. As a result, students see a failure with no suggestions on how they can improve. This lack of constructive feedback is alive and well in the form of multiple-choice and high stakes assessments, which simply require a student to get the right answer.

Traditional classrooms do not allow for much exploration of subject material. Instead, most classrooms employ direct instruction in which the teacher lectures the students about a given topic. This is unfortunate considering there are methods of instruction that have been found to be more effective than direct instruction, especially when it comes to understanding a topic (Schwartz, Chase, Oppezzo & Chin, In review). It is recommended that students experiment within a subject so that students become familiar with the deep structure that lies within the problem instead of being distracted by inconsequential features (Schwartz, Chang, & Martin, 2006). In this approach, rather than being told what the correct answer is, students come to understand the subject by reflecting on what they have tried, what worked, and just as important, what failed.

The fact that students are avoiding failure is troubling. Researchers, such as Kevin Dunbar, believe that failure is the key to innovation and discovery. Dunbar sought to gain a deeper understanding of scientific study and experimentation by observing scientists at work. During this time he discovered that most innovations occurred when experiments did not go as planned (Dunbar, 1999). An unexpected outcome indicates many things about the model used to predict the outcome of the experiment; Mainly, that the model used may be incorrect, or incomplete. The resolution of this failure leads to stronger and more accurate models (Andersson, 1982). It makes sense that new knowledge would spawn from behaviors and models that we don't completely understand.

Seymour Papert also appreciated experimentation and failure within a space in order to become familiar with it. Microworlds, self-contained worlds with discrete rules, were proposed as such a space in which students could experiment (Papert, 1993). Papert created the famous mathematical microworld of logo, a computer program that allowed students to control a virtual turtle with simple commands. The commands, which were mathematical in nature, could then be strung together in a program that would allow the turtle to draw a picture. Papert argued that by testing the bounds of this world, and subsequently finding what doesn't work, students were able to experience the language of math in an immersive way. James Gee found similar learning environments in videogames.

The sandbox principle, as Gee describes it, is one of the necessary elements found in good video games (Gee, 2003, 2005). In a sandbox, players are allowed to work within a space where risk and

danger is mitigated. This experience and definition is similar to that of Papert's microworlds. Industry has also come to understand that exploring the state space of a game is a key component to creating a fun game. In other words, failing is part of the fun. Koster gives the example of Tic-Tac-Toe, and how the game becomes boring once all possible moves have been realized (including those that do not result in a win state) (Koster, 2005). Schell also notes that the complexity of the state space, and the resulting exploration of this space, allows for the creation of a good game by keeping the player interested (Schell, 2008). Because exploration, and in turn failure, is a necessary component of good games, we might be able to look to videogames when creating a space where assessment is present but still allows for a student to fail.

Players fail a great deal before they become proficient in any sense. Most modern videogames now have a ranking systems of some sort built in as a measure of proficiency. These can come in the shape of leaderboards, statistics, or levels. Often times these statistics can be unfavorable; however, rather than discouraging players, they serve to drive a player to succeed. This remains true in games where players receive negative, sometimes degrading feedback. In *Katamari*, the King of All Cosmos constantly berates the player's progress, even when s/he meets the game's objectives and completes a level (Namco, 2004). More recently, *Portal* 2's main antagonist, GlaDOS, can also be heard criticizing a player's performance (Valve, 2011). Obviously, failure and negative feedback does not effect the player in the same way that it would a student in a classroom. Most of the time, this failure actually leads to "recursive play" where players reflect on performance and hypothesize ways to do better (Squire, 2011). This begs the questions: How might we capture this positive feeling towards assessment and failure that commercial games seem to possess? Why is this feedback not interpreted in a negative light?

I believe the answers to these questions will be critical to our understanding of why failure is avoided in schools, but sought out in games. It is my hope that we consider how failure is presented in commercial games when creating learning environments in the future.

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# Gameful Learning and Global Social Problems

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**Abstract:** In Fall 2011, we taught an experimental course pilot for a required undergraduate course in Global Social Problems. We designed this course using a gameful approach that was heavily inspired by the work of Jane McGonigal. Students were given the opportunity to take heroic action through three course missions to research and take action to deal with various global social problems. Ten heroic character traits were used to frame course activities. A peer review process was used to assign scores and award student profile badges based on each trait.

## Gameful Learning

What does it mean to be gameful, or to be a part of a gameful activity? According to Webster's, to be gameful means to be, "Full of game or games" (Webster's, 2012). Jane McGonigal's perspective is more nuanced; being gameful is synonymous with serious play—to confront a serious challenge and to "learn and improve" in some way as a result (McGonigal, 2011, Chapter 1). Moreover, McGonigal challenges us to rethink and reinvent our notion of everyday participation in ways that are gameful. To do this in an educational context means providing students with the chance to, "turn intellectual strengths into superpowers, tackle epic challenges, and fail without fear" (McGonigal, 2011, Chapter 7). Gameful learning empowers learners through challenge in ways that are constructive and learner-centered, that guide students through thoughtful reflection, and that motivates students to "change the world in meaningful ways" (McGonigal, 2011, Chapter 11). Gameful course designs can thereby help students to build agency and confidence, and inspire critical evaluation of the world in which they live. McGonigal used a gameful approach to design the real-life alternate reality games *World Without Oil* and *Evoke*. This approach enabled players to participate in ways that motivated them to work at community levels to address serious social problems. Similarly, we provided students with the time and tools to address social issues through social media participation, as well as through involvement with local community organizations. Students collectively created blog entries, reflections, tweets, posted a YouTube video, commented on online news articles, volunteered their time and engaged in fundraising and awareness activities. We adopted a gameful framework by which student activities were grounded through a set of ten "heroic" character traits (our course values). A peer review process provided a scoring system by which students earned character trait points, and 'superhero-themed' badges were posted on public profile pages. It was our hope that a gameful approach to learning about global social problems could provide opportunities for "epic wins" by encouraging students to tackle projects important to them, and to encourage participation that was "heroic" and "satisfying". (McGonigal, 2011, Chapter 12).

## Course As Superstructure

Students do not often get the chance to tackle real global social problems within the context of a required class. However, such perspectives are essential if we aim to help students gain global perspectives. Attaining these perspectives requires that we respond to "an ethical call to action", to "reach beyond the classroom to the larger community...and to connect theory with the insights gained from practice" (Hovland, 2006; AAC&U, 2002 as cited in Hovland, 2006). We were thus determined to reinvent the *idea* of what a class could look like, and in doing so adopted what McGonigal refers to as a "superstructure" for our class to foster a highly participatory learning environment (McGonigal, 2011, Chapter 14). The Global Social Problems course at St. Edward's University was heavily inspired by the ideas and superstructure that drives *Evoke*. *Evoke* is organized into a series of weekly missions; each mission challenges players to respond a 'call to action' to address a given social issue. We similarly organized our class using a mission-based framework. Students had to complete three missions in the class: to Research a global social issue, take Action to address the issue, and Imagine a solution to a chosen social problem. Unlike *Evoke*, students were able to select any global social problem to address, and student teams formed during the Action mission to tackle a broad social problem. Teams tackled issues ranging from Consumerism to Water Security, Poverty, War in the Democratic Republic of the Congo, and Gender Inequality. The overarching goal for this class was to offer students the opportunity to take heroic action to address real social issues through in-depth research, inquiry and action through social media and non-profit volunteer channels.

## Game Mechanics

Ten heroic character traits served as the foundation for all course activities and include: Cooperation, Courage, Creativity, Credibility, Empathy, Perspective, Persuasion, Clarity, Precision and Tenacity. In addition, students were asked to contribute their perspectives on each character trait in a live in-class brainstorm using the online tool, [Answergarden.com](http://Answergarden.com) (a collaborative brainstorming tool). The Global Social Problems course site can be found by visiting <http://academic.stedwards.edu/globalsocialproblems/>, and a listing of character traits, associated attributes and links to Answergarden brainstorms can be found by visiting <http://academic.stedwards.edu/globalsocialproblems/page/character-trait-attributes>.

Students were asked to provide scores for each of these traits to two other classmates, based on a review of their blog syntheses (<http://academic.stedwards.edu/globalsocialproblems/blog>). Ratings were accompanied by constructive and critical feedback, which was sent to each student via email. Five peer reviews were conducted over the term after blog syntheses were due, and scores were posted to student profiles (<http://academic.stedwards.edu/globalsocialproblems/page/peer-review>). Students were instructed to award a maximum of 5 points (on a 0 to 5 scale) per trait, with a maximum of 25 points awarded overall for each peer review. Superhero-themed badges (custom-created for the course by professional artists) were then awarded based on points earned. Three levels of badges were created for each Character Trait based on three corresponding attributes for each trait. Badge Levels were awarded at 8-point intervals (see Table 1). Other examples can be found by visiting student profiles on the course site at <http://academic.stedwards.edu/globalsocialproblems/users>. In addition to Superhero badges, other custom badges were also awarded for other course activities, such as Twitter participation.

	Credibility Level 1	Credibility Level 2	Credibility Level 3
	 Footnote	 Sureshot	 The Seeker
Superpower	Accuracy	Trustworthiness	Verifiability
Points needed	8 points	16 points	24 points

**Table 1: Credibility Character Trait Badge Levels and Superpowers.**

## Limitations

Students participated to varying degrees in the peer review process. While some students provided reviews for two other students, others did not. Therefore, point adjustments had to be made to ensure that people were not penalized in the badge award process. Likewise, student attitudes towards the Superhero-themed elements of the class were mixed. While some students asked their badges and visited their profiles during class, others did not. Further research is needed to determine the extent of student interest in this format. Whatever their attitudes are towards the superhero gaming genre, students demonstrated a high level of engagement in this course overall, as evidenced by their social media participation, participation in their local Action mission projects, and through anecdotal feedback.

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# Sometimes Paper IS Better: The Case of The Field Museum's Biodiversity Scavenger Hunt

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**Abstract:** Members' Night is an annual event at which The Field Museum gives members a peek behind-the-scenes with access to collections and laboratories throughout the Museum. Museum staff have collaborated to author and run museum-wide scavenger hunts in 2010 (photo) and 2011-2012 (paper). Directed at families, scavenger hunts give visitors a learning-based mission when exploring the behind-the-scenes. Technology was found to be a barrier to participation in the 2010 photo hunt, with many families lacking the ability to take photos or unwilling/unable to share photos. Feedback and technical difficulties from 2010 forced a shift to paper-based hunts of 2011-2012. Feedback from all years was positive, but the paper hunts of 2011-2012 had higher participation rates and more positive feedback than the photo hunt. Over three iterations, more than 1,000 families have participated in the hunts. Lowering barriers to participation has resulted in a rewarding experience for families at this annual event.

## Introduction

As with most museums, less than 1% of The Field Museum's collections are on display at any point in time. Started in 1951, Museum's Members' Night is an annual event that gives special access to members, guests, and their families with a goal of showcasing the Museum's science, research, collections, exhibits, and educational programs. During this two-night event, members can explore a portion of the collections that are normally closed to public viewing, interact with Museum staff, learn about cutting edge research, tour new exhibitions, and take part in activities and games. Music, art, food, and games are used to make the event an enjoyable family experience that celebrates science.

Typical annual attendance for both nights approaches 10,000 visitors. The event attracts a large spectrum of guests, from toddlers to senior citizens, although demographic data indicates that the average attendee is an adult aged 30-40 with children between the ages of 8 to 10.

## Biodiversity Scavenger Hunt

Increases in access, options, and visitorship can make Members' Night overwhelming for some guests. To address this, the Museum's departments of Biodiversity Synthesis and Education collaborated to design and offer museum-wide biodiversity scavenger hunt activities that serve as both a learning opportunity and a guide to navigate the event. The Field Museum has extensive experience in developing scavenger hunts for family and teen audiences, both in paper and digital forms. Presently, paper scavenger hunts can be downloaded from the Museum's website and are often available for pick up at multiple information desks in the Museum's main hall. Digital scavenger hunts that incorporate QR codes and multimedia content for smartphones or other mobile devices are also available, but are typically geared toward our teen audiences. Past successes have included introducing audiences to content or areas of the Museum previously unknown to the visitor. Failures have included loss of visitor retention resulting in incomplete scavenger hunts and our observation that digital scavenger hunts that require smartphones are ill-used or unused for a variety of reasons including access to technology and inappropriate fit for audience type.

Offered since 2010, each biodiversity scavenger hunt has two versions: a Behind-the-Scenes Hunt and a Museum-Wide Hunt. The behind-the-scenes areas are the most popular aspect of Members' Night and can be crowded, so the museum-wide option allows players to participate no matter how popular the event becomes. In the Behind-the-Scenes Hunt, players are given clues leading them to specific specimens on display in the behind-the-scenes areas. These specimens are chosen in collaboration with the Museum's scientific staff and showcase current research, important results, or local species of interest. The Museum-Wide Hunt consists of open-ended questions in which players can use the entire Museum to find answers. These questions challenge players to use their science

knowledge and apply it to the Museum's exhibitions and collections. The two versions are as equally popular with players and most elect to try both. Completed hunts are returned to stations for small prize rewards (such as Museum-branded pencils, water bottles, or stickers) for correct answers.

Each year, the scavenger hunt is widely promoted prior to the event with email and Facebook blasts, in the Member's Night guidebook, and within the Field Museum website. The hunts are broadly promoted during the event with banners and signs, and staff members recruit participants at Museum entrances.

In the 2010 pilot year, hunters were tasked with taking digital photos to answer to each question. The photo hunt was designed to leverage the Museum's involvement in the Encyclopedia of Life project with the best visitor photos showcased on EOL species pages. More than 100 families participated during the two-night event, taking over 600 digital photos. While feedback from those who participated was positive, many families did not have cameras with them or were hesitant to use their phones to take the necessary photos. Digital photography became an unexpected barrier to participation for the majority of people who expressed interest in the scavenger hunt activity. Many people declined to participate because they did not have a camera or did not want to email images taken with their phones. Visitors who did participate often had trouble getting their images submitted; problems included difficulty locating the correct images on their memory cards and Museum card readers not accepting their memory cards. Demographic data revealed that most participants were adults and young adults who considered themselves active amateur photographers.

In 2011, to simplify participation and address the barrier that digital photography appeared to present, the scavenger hunts were re-designed for paper and pencil only, with both paper and pencil provided by Museum staff. Players simply had to write down the correct specimen name and location for the answers. The reward system shifted from being showcased on the Encyclopedia of Life to only providing prizes of small Museum-branded items. Over 400 families participated over both nights, and demographic data revealed that the median participant had dropped from adult to youth (2011 median age = 9). The 400% increase in participation from 2010 to 2011 suggests that a major barrier to participation was addressed, although repeat players indicate that some of this difference can probably be attributed to the scavenger hunt activity becoming an established event. The paper-based hunts were increasingly popular in 2012 with over 640 families participating over the two nights; the median age continued to reach the youth demographic (2012 median age = 10). The paper-based scavenger hunts were able to reach and engage large numbers of youth and families, where the photo-hunt did not.

Feedback for the scavenger hunts from all years has been extremely positive. Most participants describe the hunts as a helpful way to guide their route around Members' Night and a fun activity for the entire family. Participants said that the scavenger hunts gave them a clear plan of action, allowed them to learn new things, and allowed them to see areas of the museum they had never visited before. Larger families or groups describe splitting themselves into teams to race against each other, an unforeseen modification that may have helped to increase the popularity of the activity. Comparing player feedback from 2010 with feedback from 2011-2012, the paper hunt is more uniformly described as fun and educational than the photo hunt. Common feedback themes were that the paper hunts allowed players to more freely explore the museum without the concerns of worrying about lighting or getting the best shot. Additionally, 80% of players indicated that the paper-based scavenger hunts helped them learn while 64% indicated that it helped them to navigate the Museum. Table 1 contains direct quotes from players who provided feedback on the 2012 paper-based hunts.

"Yes, by doing the hunt I learned about Antarctic dinos, species of birds, tarantulas, fish, komodo dragons, snakes, sharks, Audubon book, amazed at size of some birds! This is the best way to see behind-the-scenes!"  
"It got you to places we have never been, even though we come here a lot, we saw new places and learned new facts."

"I learn many new things and I like the prizes. I did photo hunt in the past but it was time consuming to download and share photos, and it was also difficult to take photos because it's so crowded and busy. I liked photo hunt, especially being part of Encyclopedia of Life, but paper hunt is easier to do."

**Table 1: Sample player feedback from the 2012 paper-based scavenger hunts.**

Paper-based activities have certain advantages that digital technologies, despite their increasing ubiquity, cannot yet replicate. Paper-based scavenger hunts are a familiar and popular activity with a

low-barrier to participation. Digital photo-based scavenger hunts were more difficult for family play because the family may have to share a piece of equipment that certain family members might not know how to use, or that equipment is viewed as personal and not wanted to be shared. The context of Members' Night may also play a role in the popularity of paper-based scavenger hunts. Members' Night is full of new sights, sounds, events, experiences, and learning moments that can result in over stimulation. Adding a camera, smartphone, or other device with a new set of mechanics might be seen as a distraction. The familiarity and simplicity of paper might be the best way to add to an already action-packed event.

## **Conclusion**

While digital technology will become increasingly ubiquitous and barriers to participation will lower with each passing year, for the immediate future, we still need to take technological barriers into consideration when designing games and activities. Activity design must consider what or if technology is really adding to participation and potential learning. Digital technology should be used in the appropriate context and when it adds unique affordances to an activity. Despite the temptation offered by digital technology, sometimes paper is the best medium to engage audiences in an informal learning experience.



# Designer Control and the Role of Space in Augmented Reality Games for Learning

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**Abstract:** Many examples of augmented reality (AR) games for learning establish both the designed, digital space *and* the physical space of the player as within the purview of the game designer. While this exertion of designer control may be beneficial for learning in some circumstances, it should not be considered inherent to AR games generally. In fact, it is potentially counter to the very affordances that make mobile technologies most powerful for learning.

## Space in Augmented Reality Games

Previous research in augmented reality (AR) games has shown that a tight link between content and place can be an effective way to motivate learners and make academic tasks meaningful. Schrier (2006) designed an AR game called *Reliving the Revolution*, which “takes place” in Lexington, Massachusetts, at the site of the famous battle. Klopfer and Squire’s *Environmental Detectives* (2007) allowed learners to engage in the social practice of environmental science and encouraged them to integrate the constraints and affordances of the local site into their problem solving. The AR games discussed by Perry et al. (2008) are similarly dependent upon their linkages to specific zoos. In each of these cases, a specific space serves as the designated setting for the game’s action, and players must interact with particular features of the space in order to complete game objectives. However, this design approach carries with it some important implications. Without access to the designated spaces, players cannot engage with precisely those features of the environment that make these games powerful for learning. This consideration means that the context in which a particular game is effective is relatively narrow.

In the face of these potential challenges, it is worth interrogating our assumptions about the nature of game spaces in AR. When we do so, we find that the tight connection between content and place is not a necessary feature of AR games for learning. Rather, the specificity of the physical space is a continuum along which designers of AR learning games can intentionally vary.

## Game Space and the Role of the Designer

Salen and Zimmerman (2006) reviewed the role of space in video games. They argued that the nature of game spaces is mediated by the affordances and constraints of particular technologies. In many video games to this point, the game space has been defined on a single plane, the plane of the digital space provided to the player by the game designer. From this perspective, the goal of the designer with regard to space is to “immerse” the player in the *designed* space, and to minimize the *physical* surroundings of the player—encouraging the player to forget the physical world.

However, AR games (and mixed reality games as well) problematize this unilateral definition of the game space by designers. AR games entail a game space that is defined on two distinct but integrated planes: the digital space of the design, and the physical space of the player. For AR games to work, the relationship must be well defined: one plane of space must “augment” the other.

*Reliving the Revolution*, *Environmental Detectives*, and other games of their ilk exemplify one response to this need. The designers of these games attempt to define an appropriate or allowable physical space from which the digital game space may be accessed. There is a one-to-one relationship. *Reliving the Revolution* can’t help you relive the revolution if, for example, you try to play from Lexington, Kentucky instead of Lexington, Massachusetts. While there are sound pedagogical reasons for the designer to exert this kind of control, such an approach is not inherent to AR and may actually run counter to some of the cultural expectations of our present technological moment.

## Player Agency: Mobile Media and Culture as Practice

Another of Salen and Zimmerman’s (2006) arguments is that game spaces both enable and constrain player action. The essay “Walking in the City” by de Certeau (1984) provides a helpful metaphor for thinking about how the player as agent and designed game space as structure interact:

[I]f it is true that a spatial order organizes an ensemble of possibilities... then the walker actualizes some of these possibilities. In that way, he makes them exist as well as emerge. But he also moves them about and he invents others, since the crossing, drifting away, or improvisation of walking privilege, transform or abandon spatial elements. (p. 98)

This statement serves as an argument for thinking about culture as practice. Cultural values and appropriate ways of being are not merely handed down to individuals by the structure; rather, they emerge dynamically from the *interaction* of the individual and the structure. Salen and Zimmerman invoke de Certeau to suggest that game spaces interact with the player's agency to mutually define possibilities in video game worlds. However, through the lens of AR, this passage from de Certeau takes on another valence. It brings into question the design goal of trying to determine the game space unilaterally.

Numerous scholars investigating the specific implications of mobile media on learning have emphasized the highly personal quality of mobile technology as one of the main affordances of mobile technology that makes it unique (Klopfer, Squire, & Jenkins, 2002; Naismith et al., 2004; Squire, 2009). Because of their small form factor and portability, mobile devices are ideal for learning content that is tailored to the individual. And yet, the prevailing design practice at this time seems to be that the principle of personalization not be extended to the definition of AR game spaces.

This is not to say that the physical space of an AR game doesn't matter; it certainly does. Squire and Klopfer refer, for example, to the way in which navigating slopes, rough terrain, and fences played an important role in players' decision making in the *Environmental Detectives* game. However, designers of AR games should broaden their perspective of AR to include designs that leave the choosing of the physical space of the game to the player. Many of the pedagogical benefits of navigating a *particular place* may still be available when navigating *any place*. As one example, the embodied cognition perspective could motivate AR game designs in which the player moves across a physical space while following her location on an on-screen number line. In such a game, moving through space can help learners "get a feel for" (Black, 2010) the difference in numerical magnitudes, but any given space will do. Projects like ARIS (Gagnon, 2010) are beginning to explore the possibilities of "play-anywhere" AR games. Furthermore, removing restrictions on where AR learning games can be played may help expand their reach to new constituencies. In other words, if instead of hanging out in Lexington the player wants to go walking in the city, maybe the designer should be ready to follow.

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# A Tool for Supporting Game Design Education: Tower Defense Generator

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**Abstract:** In education, game design is often used as a means to an end: for example, to learn computer programming. Inspired by the notion of constructional design, or the design of tools to support other's design activities, we are exploring the use of tools to support learning game design as an end in itself. We present a work-in-progress tool called *Tower Defense Generator* that allows student game designers to actively, and reflectively, explore a game's possibility space while developing a deeper understanding of the key features of the tower defense sub-genre, and how those features interact to produce meaningful gameplay experiences. TDG allows learners to use different heuristics to procedurally generate game levels that can then be analyzed, playtested, and modified. We argue that these (and other) features provide for an environment with the appropriate amount of scaffolding to encourage powerful and interesting design explorations in support of learning.

## Introduction

Game design and development is often used to help students learn something else, for example, computer programming (e.g. Overmars, 2004). When doing so, learners may develop an “experience in design (i.e., planning, problem solving, researching, dealing with time constraints, [...], and bringing everything together into one project)” (Kafai, 1996). However, the end-goal isn't for students to learn and critically reflect on game design (see Games & Squire, 2008 for an exception). We are exploring ways to help students better learn and practice game design through the use of mixed-initiative design tools. A mixed-initiative approach is one where content (e.g. game levels or maps) “is created through iterative cycles between the human designer and procedural support” (Smith et al., 2010). The idea is to empower a designer by making it easy to rapidly examine alternative designs and automatically check for basic playability (e.g. is it possible to complete this level). We are also inspired by Resnick's notion of constructional design as “a type of meta-design: [that] involves the design of new tools and activities to support students in their own design activities” (Resnick et al., 1996). We believe that combining these ideas can help us develop better tools for practicing game design while also facilitating reflection and learning about game design. We introduce a work-in-progress tool to assist in the design of “tower defense” games. Our tool, *Tower Defense Generator* (TGD), encourages learners to actively, and critically, explore the design space of tower defense games while helping them develop a deeper understanding of the key genre features and how they interact.

## Tower Defense Generator

In tower defense games players must position static defenses (i.e. towers) to prevent increasingly tougher waves of various kinds of enemies from reaching and/or destroying an endpoint. Players also collect resources (usually by killing enemies) that are used to purchase or upgrade existing towers. Successful play requires deciding which towers to build, where they should go, and when to upgrade them. In some games, tower placement is also strategic in that it can create paths or mazes that enemies must navigate, thus providing more time for the towers to attack. The pace of these games is moderate and does not require rapid button presses (Ta et al., 2009) and, from a player's perspective, they are easy to play even while they may require tactical and strategic sophistication (Avery et al., 2011). This makes them ideal candidates for learning game design; they are simple to play, but hard to understand deeply. Popular titles in this genre include the flash-based browser game *Desktop Tower Defense* and the multi-platform *Plants vs. Zombies*.

TDG is a tool for the designing tower defense games. It consists of a map generator, a map editor, and separate specifications for towers, enemies, and waves (in XML). Finally, there is a game engine that given a map, tower, enemy, and wave specifications, allows the player to play the game. Due to space, we will only describe the map generator.

TDG's procedurally generated map creator (see Figure 1) allows learners to explore the possibility space of playable maps. In addition to certain “baseline” parameters such as the dimensions of a map, TDG includes a variety of heuristics for map-generation that learners can select from, configure,

and then analyze the resulting output. For example, maps can be randomly generated after specifying general parameters such as density of certain terrain features (e.g. traversable vs non-traversable). Alternately, a branching algorithm can be used to create paths that enemies could follow. Each heuristic generates maps with a distinctive “feel”, and providing these options encourages learners to reflect on the kinds of game experiences that result from different geographical layouts and how they may align (or not) with their design goals. Rather than focusing on the creation of a single map, our tool provides several for them to analyze, question, and explore. This avoids overwhelming learners with too much freedom and helps limit the scope of their explorations to a single idea. Our approach, in a nutshell, is to provide a “grey box” that avoids the inaccessibility of a “black box” and the complexity of a translucent “white box”. By providing a way to rapidly test (play) a map and edit it, we also encourage the kind of iteration (and reflection) that is essential to design and learning. In other words, rather than help generate an “ideal” map, our goal is to help learners reflect on what features make a map successful (or not), learn to identify not-quite-there maps that could be successful after some changing, and be able to make and test those changes.



**Figure 1: Map generator and sample map with one end point and three spawn points.**

## Future Work

We are embarking on a formative assessment of our tool in a college educational setting. Additional developments include allowing users to define their own map-generation heuristics and tools for visualizing and modifying pacing and game balance. We are also exploring features for annotating maps with design goals, notable features, tracking the history of changes, and allow easier sharing.

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## **Posters**



# Video Game Workshop as a Sharing Device in Mental Health Care

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**Abstract:** The gaming culture produces questions to the standards through which health and education organize experiences for children and youth. In this paper we discuss the use of video games in workshops held with children and adolescents in a mental health service in Brazil. In this work we emphasize the sharing effects promoted by video game workshops in three levels: between game and players, between the participants, and between the video game culture.

The research group "Oficinando em rede" has, since 2004, produced a link between cognition, technology, and mental health. During this period we have developed a series of studies to explore and experiment with the effects of digital technologies workshops in a psychiatric hospital in southern Brazil. In these workshops, we deal with photography, robotics, and different authorship softwares with young people and workers in a mental health service.

During this experience, the main request made by the adolescents was to play video games. It represented, in fact, one of the main reasons for their participation, rather than the more commonly considered therapeutic activities such as working with authorial softwares, for example. Sometimes, this gaming desire caused discomfort to the workshop instructors who generally were not familiar with this media. The tension caused some inconvenience, eventually modifying the proposals of the workshops.

Faced with this question, we developed a project with three workshops involving electronic games, inpatients, and workers in this mental care service. We use the game workshops as a research method. Within a workshop it is possible to create and strengthen regimes of visibility and enunciation to express how children and adolescents develop their experience with the technology, and what goes on while they do it. The workshops will enable us to emphasize the subjects' actions and the processes of creation and composition, not only the final product. Finally, it allowed the research participants to experiment with a creative use of video games.

The workshops were held weekly, as part of the planned activities in the service. They lasted an average of 20 minutes each. Each group (children and adolescents) consisted of twenty participants. The workshops were followed by two or three workshop instructors, and at least one of them was a service technician and others were participating in the research project. The workshops aimed not only at the interaction with games, but also at providing conversation and interaction between the participants, as well as new ways of expression and communication. The workshops were structured in three parts. In the first part there was a discussion about the proposal of the workshop itself. The second part consisted of carrying out the actual workshop and finally there was a moment in which the participants reported what they did to the group. In the first workshop we used the music game *Guitar Hero*. In this game the player uses the control of the video game to simulate a guitar and he or she must proceed simulation playing in the instrument in the correct harmony in order to score points. Although the model of gameplay serves the purposes of research, the game did not seem to meet the expectations of the participants. One of the hypotheses that could explain this behavior was that the game's songs did not connect with the musical experience of the participants. In the two following meetings we brought two games: *Pro Evolution Soccer 6*, and the racing game *Need for Speed: Carbon*. Both games were more accepted by the participants.

The following analysis was made from workshop's field extracts taken by the instructors' notes. One of the key elements was the emergence of a sort of community born out of the play of video games.

The common is a place of sharing: when you share something, and take part in this sharing, we are forming a common surface, which makes us belong to a community. The common is set as a place that constitutes our political experience because this common is a construction, not a natural place. It is not established a priori as well as the universal ideas (derived from reason). Neither given as standards with purpose of uniformity. The common is not related to what's similar, but looks for the singular, something that came from each one and can be shared by negotiation and exchange.

## **Video Games, Community, and Sharing**

The relationships established in the video games workshops showed moments of a collective unit, a care community. Attitudes such as helping the colleagues in the understanding of the rules or the controls of the game emerged, as well as inviting and encouraging others to participate in the game. These attitudes have provided moments of exchange, learning, and knowledge construction—a space for interaction, sharing and coexistence.

In video games workshops, we observed three distinct but complementary types of sharing. The first one is referred to coordinating actions with the game world itself. Each game is constructed by different rules and possibilities. Due to these characteristics, a game requires coupling, i.e., coordinating actions with this micro-world. This is a condition that enables the participants to invent their own paths. The characteristics of games may allow more or less immersion according to the attitudes of the participants and the affordances of the virtual environment. The relationship established with the game makes you feel like you belong and are a part of that universe, and with it comes the feeling that one has the potential to play, compete, or win.

The games are challenging because they put the player in front of unusual situations of risk where he can experience them without being physically there. Somehow, the player is there, because the game has the potential to make the events seem real. Gee (2009) says that "players are encouraged to take risks, explore, try new things. In fact, failing in a game is a good thing" (p.171) Resulting from this, we could see in the workshops a second type of sharing experience. The participants helped each other in understanding the rules of the game, and in sharing their abilities. The beginners pay attention to the more experienced.

A third type of sharing comes out of the culture of games, which brings attention to the standards by which health professionals and education experts organize designed experiences to children and youth. One of the attractions of the games seems to be exactly their endogenousness, in which the motivation and context are inextricably linked to the gameplay.

It was evident in the workshop that the games are not closed worlds: they are connected to other contexts, producing sharing beyond the current game. Even when it comes to young players, such as the participants discussed here, there is the articulation of the games with other softwares, such as internet search engines—like Google—and the possibility of having their own group experience in the workshop or publishing it on the blog.

Games promote such cooperation, producing an in-common experience between players. Gee (2009) speaks of players who are not only consumers but also producers, who do not get their information ready, but help to "write" their world. This is a positive way of thinking about games, as opposed to simply thinking that they "are no good." Good games work as simulations that teach ways of living that can be transported to people's daily lives, producing features like cooperation.

The author also says that games provide players "a real sense of agency and control," giving a "sense of ownership about what they are doing". These possibilities are very important when we think of children and young mental care work. In our experience, the workshops have opened a space and put in the hands of children and adolescents ownership of what they were doing. This works by giving them the freedom to choose something about their actions. We then see the video games as a powerful generator of speeches in such an environment.

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# Moving From Content to Discovery: STEM for Younger Learners

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**Abstract:** This poster addresses the question “What are the implications for STEM-focused games and interactive media spaces when pedagogical foci shift from content-based to discovery-based approaches?” The intended audience is broad, from educator to researcher to developer. Information presented includes not only content from literature and industry reviews, but also from field professionals following their own professional applications of STEM in the development and implementation of learning environments. The target outcome is to address current challenges and opportunities prompted by shifting STEM pedagogies from content-driven to discovery-driven learning environments. In embracing these pedagogical shifts, the development and application of game and interactive media spaces serve to provide young learners with deeper foundations on which to build long-term STEM literacy and achievement.

## Games as a Vehicle for Shifting Approaches to STEM Learning

At its core, Science, Technology, Engineering, and Math (STEM) pedagogy is about fostering curiosity and discovery. It is about instilling in children the desire to find out on their own, not always to be taught (Fisher, Bryant, Akerman, & Fischer, 2010). While discovery is a natural inclination of children, it has not been a fundamental goal of today's traditional science and math pedagogy. While standards-based educational frameworks are changing to include practices of science and engineering and crosscutting concepts (NRC, 2011), traditional pedagogical structures focus much more on disciplinary content. Ideally, STEM is about encouraging exploration of the environment, asking questions, and being curious beyond initial comprehension. Doing so fosters the *mindset* of STEM rather than the facts of STEM. This poster argues that games are a key medium in which to support children's development of a STEM mindset.

Sometimes fostering a STEM mindset is as simple as giving a child the space to wonder, and the tools and encouragement to try out ideas. Games and interactive media spaces can be powerful environments for such wondering and experimentation to playfully take place. They are ripe with opportunities for meaning-making. Play that takes place within game spaces requires high level of textual understandings. Game worlds require players to make sense of signs, moving back and forth between interactions with known and unknown information. Players gain understanding by interacting within the world, and by making interpretations that shift and change based on the way the players use signs and symbols in different ways (Salen and Zimmerman, 2004). What play through various media allows is the possibility for children to create patterns of knowing and understanding based on experimentation, discovery, and role negotiations. Mediated play, therefore, becomes a tool with great promise for STEM supportive environments for younger learners.

## A Poster to Identify Implications for Development, Implementation, and Research

With so many products proliferating the market, particularly those claiming to have educational merit, how can developers, educators, and researchers evaluate existing products to identify critical elements of STEM play? Beyond this, how can researchers and developers understand media needs, trends, and opportunities in order to further develop STEM supportive products and platforms? This poster will identify issues regarding the development, implementation, and research of games and other interactive media platforms for supporting STEM learning for young audiences, particularly preschool and early elementary ages.

## Statement Samples for Inclusion From Industry Professionals

**Carla Engelbrecht Fisher**

**Founder, No Crusts Interactive**

Games are a perfect opportunity to grow this mindset as well as help reeducate adults about STEM learning experiences. Intergenerational play, including cooperative simultaneous play as well as pass-back-and-forth interactions, are increasingly supported by the various gaming technologies. Game designers and researchers should leverage these trends to explore the STEM educational

opportunities for both children and adults, particularly through games that foster cooperation, trial and error, and holistic systems thinking.

**David E. Kanter**  
**Director, SciPlay**

In my early work, I explored the impact of project-based science curricula in formal classroom settings. Such curricula were designed to support students working on real-world projects. My findings were interesting in that I could show that these kinds of curricula brought about improvements in students' meaningful understanding, but students' affect did not improve in parallel as initially anticipated. While I believe such curricula are a good approach for developing meaningful understanding across disciplines, I have become concerned about their negative impact on affect due to the significant mental effort they require, resulting in a situation that is at odds with ideal classroom practices and thus negatively experienced by students. Taking a different tack, I have recently begun to explore the potential of guided play games to improve both affect and learning. I believe that play in an informal setting can be carefully guided as a game-with-rules that integrates science content in a compelling and intrinsic manner. Also, such play may serve as an important bridge from the informal to the formal setting to promote deeper understanding while also building students' positive affect toward science.

**Scot Osterweil**  
**Creative Director, MIT Education Arcade**

While harnessing the natural curiosity of children in the service of exploration is a necessary first condition of STEM education, it is not in itself sufficient. As children explore the world, their curiosity leads them into observation and sometimes hypothesis formation, but it can also lead them to misconceptions and even magic thinking. Properly taught, STEM education helps students understand that the formation of knowledge comes through systematic modeling, testing and iterating as well as exploring. Traditional education kills the exploration by emphasizing the memorization of facts, but it also fails at promoting systems thinking by reducing it to a "scientific method" that flattens the experience for students, and drains the sense of wonder from what should be inspiring engagement with real phenomena. Happily, though this form of systems thinking does not come easily, it does emerge in the ways children engage with the models and simulations that animate most electronic games. Through game-play children do learn to reason about cause and effect, test hypotheses, and control for variables. The challenge of designing opportunities for reflection into the game ecology is second in difficulty only to the challenge of designing a genuinely engaging game, but it is a challenge well worth the effort.

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# Exploring Coherence in Student Game-Based Learning Narratives

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As game-based learning (GBL) activities grow in popularity, research must address not only the content and mechanics of game play, but also the classroom experiences that contextualize GBL activities. A better understanding of how students relate to GBL is paramount; toward that end, this paper proposes an analytical framework for interpreting student narratives about classroom gameplay. Narrative inquiry using Linde's (1993) coherence model of storytelling offers a way to introduce student voices to the GBL literature and improve implementation for educators interested in GBL.

## Game-Based Learning: Missing Stories

Can we use games in education? With the advent of digital games and the avid gaming cultures they engendered, this question has captivated educators' and researchers' attention. In the resultant scholarly literature, games now figure both as models of the learning process and tools for enhancing learning in the classroom and beyond (Gee, 2003; Shaffer, 2005; Squire, 2005; Prensky, 2001). For many, game-based learning (GBL) promises to bridge achievement gaps while nurturing students' motivation and sense of self-efficacy (Barab, 2009; Ip, 2011). Realizing this promise is not a simple matter, however. As Pivec et. al. (2003) point out, GBL activities constitute "radically new ways of learning" (p. 216). This poses a challenge to educators: is it possible to weave academically atypical experiences into a classroom setting?

Game design research offers many approaches to this question (Charsky, 2010). Studies emphasize the importance of situated meaning, consequential context, intrinsic integration of content and mechanics, and rich narrative structure for successful game construction (Barab, 2010; Gee, 2003; Habgood, 2005; Ip, 2011). Valuable as such insights are, the stories design studies tell position the game itself as the hero, charged with saving students from a dreaded "bad outcome" (e.g. a poor grade, a drop in self-reported interest). Coupled with a tendency towards quantitative aggregate assessments of game effect, this emphasis on game-as-unit of study permits dialog between GBL research and dominant modes of educational evaluation. However, it also leaves many voices—particularly student voices—unheard.

Much remains to be said about what happens "when games enter the classroom" (Squire, 2005, p. 1), and how students make sense of game play in this setting. The current study proposes an analytical framework—narrative coherence (Linde, 1993)—for investigating how students situate GBL activities within stories they tell about their own learning. Foregrounding student voices, narrative inquiry allows students to express their experience and understanding of GBL as it relates to an educational context. Linde's (1993) framework enables researchers to ask: how do students create coherence in their learning stories when these stories include the experience of classroom game play?

## Creating Coherence: Toward an Analytical Framework for GBL Studies

Linde (1993) describes coherence as a property of a text: it "derives from the relations that the parts of a text bear to one another and to the whole text, as well as from the relation that the text bears to other texts of its type" (p. 12). Coherent relations establish reasonable causal connections between activities and personal development, in a socially sharable form. Describing the sorts of logical work speakers undertake to create coherence in their oral narratives, Linde develops an initial typology of coherence management strategies. These include tying action to character traits, providing multiple angles of explanation to bolster an otherwise weak narrative link, and relying on temporal sequence to illustrate causality. When these strategies fail, Linde notes that speakers experience "personal and social discomfort" (p. 4): coherence is not simply a property of texts, but one for which speakers actively strive.

In Linde's study, the "texts" are choice-of-profession stories spoken by her informants; in GBL research, the texts of interest would be students' learning stories. These stories would reflect on all the experiences that lead to learning a particular topic (e.g. basic French grammar, the scientific method, the history of WW2). The "parts" of the text here are narratives about individual learning experiences (attending a lecture, reading a textbook, playing a game). If games indeed "constitute

radically new ways of learning,” game play may not easily cohere with other academic activities. It can therefore be hypothesized that in attempting to reflectively integrate game play into an educational context, students will need to employ many of Linde’s coherence management strategies (Table 1).

Within this frame, several central questions emerge: How do students relate game play to other forms of study? Do they experience games as coherent with more common academic activities? If so, why? If not, how do they manage this coherence threat? Is a learning story that includes a GBL narrative commensurable with more traditional learning stories? If so, how? If not, how is this managed narratively by the speaker? Collecting and examining student narratives for answers to these questions offer at least two key insights. First and most practically, learning how students experience classroom game play enables educators to better scaffold GBL activities. Second, and perhaps more fundamentally, including student voices in the growing GBL literature more fully enacts the educational shift GBL represents. Many proponents of GBL argue that learning takes place when information is situated in a meaningful narrative context (Barab, 2010; Ip, 2011). What is true in the classroom is true in research as well: if you want to teach a student, tell her a story; if you want to learn how to teach a student, listen to hers.

Strategy	Characteristic Logic
Meta-Continuity	“Logically the most complex” (p. 157) of coherence strategies, this is the driving force behind the GBL paradigm. Meta-continuity affirms “multiplicity [and] change” (p. 157), holding that something “radically new” can be more coherent with educational aims than something traditional. Here, a game’s academically atypical nature becomes an asset, aligning game play with learning styles that education-as-usual tends to suppress.
Character	This strategy relies on personal character traits to explain decision-making. “Life stories express our sense of self: who we are and how we got that way” (Linde 1993 p. 3); likewise, student learning stories express their sense of themselves as students and how this identity impacts cognitive and affective aspects of learning.
Temporal Linkage	Illustrating extended temporal duration or highlighting the temporal sequence of events establishes causality in narratives. Aligning scholastic experience with objectives set out in course syllabi or elsewhere is predicted to be a key coherence strategy for students.
Multiple Non-contradictory Accounts	An accumulation of diverse, mutually supporting explanations for a given event serves as strong justification for an agent’s narrative progression. For students making sense of diverse learning experiences (e.g. lectures, lab, reading, online research), this is likely an important strategy.
Discontinuity Without Account (Complaint)	Linde (1993) construed this strategy as a “less than ideal way of presenting a life story” (p. 159); she treated it largely as a case of last resort. However, the strategy of complaint seems key in the academic environment; it is a way for students to “restory” (Linde, 2008) their experiences and exert evaluative agency in a context that determines much of their narrative progression for them.

**Table 1: Coherence Strategies as they Apply to GBL Studies**

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# Leveraging English Learners' Identities in Game Design

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**Abstract:** This paper provides recommendations for game designers to facilitate Spanish-speaking English learner success. Authors draw upon literature that examines socio-cultural, educational, and identity factors impacting the academic achievement success of Hispanic English learners. The paper briefly describes how and why game designers should (1) leverage Hispanic English learners' Spanish-speaking ability to provide improved identity positions within content area classrooms and (2) draw upon and reinforce elements of Hispanic culture such as: *familismo, respeto, and allocentrismo* (as identified by Wilkins and Kuperminc, 2010) in order to improve students' learning.

English learners (ELs), especially Hispanic ELs, can struggle with academic success (Kuperminc, Darnell, & Alvarez-Jimenez, 2008; Perreira, Harris, & Lee, 2006; Suárez-Orozco et al., 2011). There are several ways in which game designers may help Hispanic ELs to be successful. This paper recommends two primary elements that game designers might use to improve Hispanic ELs' success: (1) leverage Hispanic ELs Spanish-speaking ability for better *identity positions* within the classroom (see Norton & Toohey, 2011), and (2) draw upon significant elements of Hispanic culture as described by Wilkins and Kuperminc (2010): *familismo, respeto, and allocentrismo*.

## Leverage Spanish-speaking Ability

It is most important for game designers to improve ELs' position in discourse in the classroom setting from marginalized to respected. This could improve ELs' academic identity, participation, and self-efficacy. This can be done by incorporating game play elements that require a Spanish speaker. For example, the participatory augmented reality simulation (PARS) *Alien Contact!* requires students to fill the roles of chemist, cryptologist, hacker, and FBI Agent (Dunleavy, Dede, & Mitchell, 2009). This game (and others like it) could offer a setup option to include a Spanish-speaking member. If this option were chosen, the chemist (or other academic) character would receive all (or most) information in Spanish and the NPCs whom the player encounters could be older Spanish-speaking academics. Legitimizing and necessitating the skills of a bilingual student validates the student's bilingual, bi-cultural identity in an academic context while promoting a better identity position in the class. This validation of bilingualism promotes academic and life success (Schwieter, 2011).

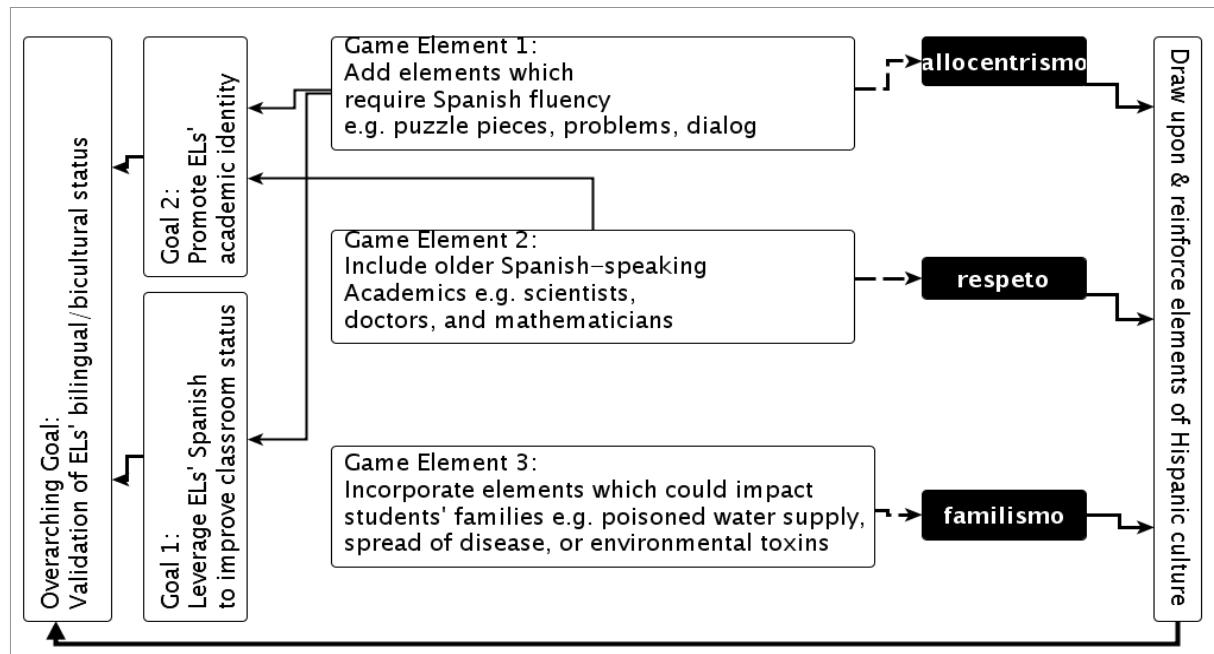
## Draw Upon and Reinforce Hispanic Culture

Wilkins and Kuperminc (2010) indicate that *respeto* is an important cultural component of the Hispanic culture; *respeto* signifies respect for older members of the community. Game developers could tap into this cultural component by utilizing visibly older (graying) native Spanish speakers as NPCs in PARS and video games. This could serve to lower students' affective filters and support positive academic identity formation. Norton & Toohey's (2011) synthesis of literature indicates that students are constantly in re-imagining themselves and their place in the world; providing examples of Spanish-speaking academics will help facilitate students' perception and belief that Spanish speakers can be academics—further, such portrayals will serve to counteract negative stereotypes of Spanish speakers that students may be bombarded with in US culture (Lippi-Green, 1997).

The concept of *familismo* refers to an emphasis on the centrality of family. Researchers (Kuperminc et al., 2008; Suárez-Orozco et al., 2011) indicate that Hispanic ELs' alienation from school and academics is at least in part because they (ELs) do not perceive that school benefits their families. Therefore, it may behoove game designers to include elements that illustrate how science, math, and other content knowledge may benefit students' families and communities. For example, students might be called upon to fight the spread of disease, determine the cause/source of a poisoned water supply, or identify environmental toxins that could (in real world situations) impact their families.

*Allocentrismo*, the importance of group goals over personal goals (Wilkins & Kuperminc, 2010), complements games such as PARS, which utilize a jigsaw like structure requiring collaboration (Dunleavy et al., 2009; Rosenbaum, Klopfer, & Perry, 2007). However, Rosenbaum et al. (2007) indicate that while engaged in *Alien Contact!* certain students would 'help' other students to solve their

tasks. This type of 'help' might occur frequently when ELs are rushed to solve problems that require English fluency. A game play option which requires a Spanish speaker would limit such 'help' and require that ELs participate - while reinforcing and drawing upon notions of *allocentrismo*.



**Table 1: Utilizing game elements to benefit Hispanic English learners**

## Conclusion

These recommendations are not without possible caveats. Spanish speaking ELs could be made to feel awkward in several ways (see Duff, 2002). They may be accustomed to being silent in the classroom or they might find it awkward to acknowledge that they speak Spanish. However, the aforementioned options offer collaboration, identity formation, and validation of bilingual status that provides a stark (and preferable) contrast to 'typical' science classroom environments, which can marginalize ELs' participation and identity.

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# Gaming and Programming Affinities in Modding Communities

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**Abstract:** In this paper, I use JP Gee (2004)'s notion of affinity spaces to theorize the typology of divergent game modder identities. Studying varying routes for participation in modding observed within Civfanatics—an online *Civilization* based fan modding site, I investigate players' motivations to mod and thus, how they learn to mod. In this paper, I present a typology of varying modding inclinations as observed within an online modding community.

## Introduction

Over recent years, a growing body of work in the field of education and the computer sciences has identified game modding as a “cutting edge” avenue for fostering a broad range of critical information technology practices. However, as we further research and design of platforms that can leverage game modding to teach computer programming, it is imperative that a mature theory of learning through modding and learning to program through modding, takes into consideration the varying motivations that sustain it and the trajectories of productive participation that are innate to affinity-based (J Gee, 2005) fan practices, like modding. Studying varying routes for participation in modding observed within Civfanatics—an online *Civilization* based fan modding site, I investigate how players characterize mods and mod-production processes, i.e. how do modders with varying levels of technical expertise learn to mod and how do their motivations (or affinities) shape the way they perceive mod-production? Through discourse analysis of player interviews, in corroboration with their mod-production activity online, I present a typology of divergent modder identities.

## Theoretical Perspectives

Traditionally, from a sociocultural learning perspective, learning through participation in community of practice (Lave & Wenger, 1991) or through apprenticeship (Rogoff, 1995) has been characterized as learning within a community in which less experienced members are engaged in a culturally organized activity, eventually becoming capable of mature participation or “full membership”. From this perspective, the functional value of knowledge is exemplified by exemplar participation and better understood by characterizing what such participation entails (e.g. “becoming a mid-wife”, Lave & Wenger (1991)). Nonetheless, the source of motivations to engage in fan-based production practices, such as making game mods, machinimas or writing fan-fiction defy traditional viewpoints about exemplar expert identities, in that these practices are essentially amateur productions for fan-based or *networked audiences* (Varnelis, 2008); as such, these practices may be best depicted as being *affinity-based*. Gee (2005) describes affinity spaces as loosely knit participatory spaces where members of the online community coalesce around broad common pursuits, with ample mobility to pursue individual interest. In other words, affinity spaces can be thought of as niche networks of common goals, resources, and peer support. Players in these spaces engage in an intrinsically motivating activity, or fan-pursuit, to author game-based media artifacts as a way to remediate their game play experiences (Squire, 2006).

## Research Context and Findings

Analyses presented in this short paper have been conducted on data drawn from a larger dataset collected in a 2-year discourse centered online ethnographic study of the online game modding community in Civfanatics. Civfanatics, one of the most popular *Civilization* gaming sites, is a central hub for numerous fan-produces artifacts and gaming discourses, and thus, can be thought of as a niche affinity-based modding space for *Civilization* fans (Durga, 2012). Player profiles included in this study were interviewed about their interests in modding and experience playing *Civilization*, a detailed account of which has been elaborated in Durga (2012). Through a critical discourse analysis (Gee, 2005) of three participant interviews excerpts, the three modding inclinations were characterized as: (a) mod-savvy, or displaying an eclectic disposition in selecting mods to play, (b) “improvisational play,” or constantly striving to become a better player or (c) being a hobbyist/amateur programmer who may have little or no intrinsic motivation to play the game, but seeks membership in the community, nonetheless, and leverage the community's collective capacity to encourage programming. The typology of modders (Durga, 2012) revealed that motivation to mod is an amalgamation of interest and abilities that get exemplified through six prototypical mod-production practices, evidenced in these three kinds of modder profiles, illustrated in Figure-I below.

## Typological compilation of modder identities

Mod savvy	Improvisational play	Hobbyist /amateur programmer
<p><b>1. seeking for new mods</b></p> <p>Mike: "Is there any mod that gives the AI preferences to predict which civilization a newly created colony turns out to be? Has anybody made a mod like this? Is this something that would be relatively easy for someone with no python skills?"</p> <p>// After several posts with sample codes to accomplish it //</p> <p><b>2. tracking down solutions for mod</b></p> <p>Mike: "Cheers for the information guys- I managed to track down Octavius's mod that does this. You can add up to 5 Civilizations so they spawn as derivatives."</p>	<p><b>1. Remediating game-play</b></p> <p>Andy: "Modding is a necessary component to become a better player." Interviewer: what do you mean by "necessary?"</p> <p>Andy: Well, so a game in Civ takes weeks to finish. Without an editor you wouldn't be able to play it as many times to say if you had to figure out the AI."</p> <p><b>2. Postulate game strategies through modding</b></p> <p>"I mostly use the <i>World Builder</i> to set up the map, new add units or rules to the mod. Anything more unique, graphics or special units <i>takes a lot of time</i>" [Emphases added].</p>	<p><b>1. Intrinsically motivated to code</b></p> <p>Interviewer: are you a programmer? Will: Yeah spare time :) No education yet. I enjoy coding and currently this is my big project. I just finished making a replay parsing script :)-) Interviewer: tell me more about this replay script.</p> <p><b>2. building tools that address fan-requirements</b></p> <p>Will: "I'm a bad example, would have thought you wanted a more experienced civ gamer :-). "Anyway so, there was no kind of replay function [for Civ V], like you have for all the previous versions. So I built web interface around a python script I found on CFC that parses saved game files and presents them as HTML files you see in this link."</p> <p>/link truncated/</p>

**Figure 1: Corroboration of significant excerpts from interviews and forum activity depicting modding inclinations**

## Conclusions

In our attempts to find “productive” value of game modding we have perhaps remained shortsighted by focusing on the obvious and immediate “effects” of modding as a motivation to program that, at its best, has only resulted in superficial adaptation of “mods” as one of the several other project-based pedagogical approaches (for instance, game programming) to teach students to program (Kafai, 2006). However, as can be seen from this study, player motivation is a primary determinant of learning to mod within affinity-based contexts. In other words, since competence development in modding is contingent upon a player’s will to engage in modding, it is crucial that we draw attention to and elicit motivational contrasts that exist within an increasingly interdisciplinary practice, like game modding. Again, these inclinations must in no means be understood as being mutually exclusive; rather they provide ways in which players’ choices about “coding” approaches make sense in the context of modding, i.e. mod savvy players in their modding approaches, seek to understand the abstract models of the game and thus translate it into code. While, players already coming into modding spheres with a propensity to work with codes, such as Will (see figure above), seek for ways in which they can exercise and implement certain coding strategies to build something in-game or for game, drawing upon an abstract understanding of the game to begin with.

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# **“Are We Having Fun Yet?”: Evaluation, Player Retention, and Lessons Learned from Vanished, the MIT-Smithsonian Science Mystery Game**

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**Abstract:** Vanished was an eight-week long “curated game” modeled on ARGs and developed by MIT and the Smithsonian to draw middle-schoolers into thinking like a scientist. In an effort to understand how to attract and retain players throughout the run of future curated games, we will examine gender differences in engagement and which factors were positively associated with longer play times. Girls (who were nearly half our players) favored social and narrative based tasks, while boys favored achievement/social ranking based tasks. For both genders, accessing social data about other players and scoring high numbers of achievement points were positively associated with continued play. We recommend that designers of future curated games or other multiplayer educational games carefully design compelling narratives, “networked publics” and achievement systems that reward “science newbies” as well as experts in order to engage and retain players.

## **Description of Vanished and General Notes**

Vanished ran in the spring of 2011 and was the first “curated game”—a collaborative game modeled on alternate reality games (ARGs), and designed to foster engagement and scientific thinking through collaborative mystery-solving. The design was inspired by conversations with Smithsonian scientists, who found that science instruction rarely modeled scientific practice. Whereas traditional scientific instruction focuses on rigidly defined processes, perfect prediction of results, and memorization, professional scientists’ work involves collaboration, experimentation, and the unexpected. To model these processes, we developed a set of diverse, collaborative activities that players would need complete to solve a science-based mystery. Middle schoolers logged into a website expecting a typical educational game, but instead found a video of MIT students saying that the site had been hacked. Embedded in this video were snippets of an encoded message. This “rabbit hole” led to broadcasts from scientists in the future, saying that an unknown disaster had destroyed the historical record and they needed the players’ help in figuring out what happened. Players had to engage in a variety of activities, all related to scientific inquiry, to unravel the mystery story. Activities included video conferences with Smithsonian scientists, in which they shared their hypotheses on what might have happened and asked for feedback; virtual archaeology digs, where players used a Flash game to navigate an area and dig up objects, some of them actual 3D scans of bones from the Smithsonian collection; collaborating with other players on the forums; and environmental data collection.

## **Gender Differences in Play and Demographics**

Vanished players tended to come from zip codes that were slightly wealthier and better educated than the average. They were more likely to be rural and less likely to be from “majority minority” areas. Vanished attracted and retained nearly equal numbers of boys and girls, with girls making up slightly less than half of all players throughout the game. Gender and socioeconomic status was not significantly correlated with retention. Girls spent significantly more of their time than boys on social behaviors, such as composing forum posts, reading the forums, and filling out surveys. They also spent significantly more of their time accessing the secret document library, which contained “found documents” (letters, diaries) that revealed both scientific clues and narrative background to the game. Boys, on the other hand, were more likely to spend their time on achievement-oriented tasks, such as Flash games and accessing leaderboard and achievement point pages. While it appears that girls were less drawn towards these competitive behaviors, this should not be misconstrued as evidence of girls “checking out” of achievement based tasks. In fact, the average girl earned 15% more achievement points than the average boy. Given these differing preferences, we recommend designers include a variety of activities to engage a diverse player base.

## **Factors Associated with Player Retention and Design Recommendations**

Of the 6,750 players that registered for Vanished, 10% logged in for the end of the 8-week game. While attrition is to be expected, we would certainly like to retain more players. Based on analysis of the activities that were positively associated with player retention, we feel that future curated games should emphasize two major design aspects. The first is the inclusion of skill-based tasks, with clear progress delineated by an achievement points/badge system, and significant support for players who may lack confidence or adequate background instruction in the sciences. The second is the creation of a “networked public” that allows a safe space for players to connect with their peers, learn about each other, share information about themselves, and form online identities. These activities align with two major categories (Achievement and Social, respectively) of motivating types of play as identified in massively multiplayer games by Yee (2007).

It appears that Vanished players of both genders have a strong desire to connect with and learn about their peers. Players spent approximately 12% of their time looking at each others’ online profiles, despite the fact that, due to privacy restrictions, these profiles were very basic. Furthermore, accessing player profile pages was significantly correlated with retaining players throughout the run of Vanished. At first glance, this interest in peers and community suggests that Vanished fills an empty niche for age-appropriate, science-focused “networked publics”, defined by Ito et. al. (2008) as social networks with a primary emphasis on “producing and circulating culture and knowledge” (p. 10). But, despite this apparent interest in understanding fellow members of a “networked public,” reading and commenting on the Vanished forums was negatively correlated with player retention. It may be that the limits placed of profiles hindered players in expressing their identity and connecting with others. Ito et. al. noted that “some of the drivers of self-motivated learning come...from youth observing and communicating with people engaged in the same interests, and the in the same struggles for status and recognition, as they are” (p. 11). If we could find a way for players to safely share more information about themselves, they may feel more comfortable with their identity and the community, and by extension, with communicating with and learning from their peers throughout the game.

Scoring a high number of achievement points was also significantly correlated with persistence in the game (see Table 2). This is unsurprising. An individual who excels at a task, game based or otherwise, is likely to persist. However, we want to reach less scientifically skilled players, so future games should strive to give “science newbies” that same sense of expertise and accomplishment—perhaps through a dynamic achievement system that values individual improvement over time compared to a player’s initial abilities, rather than predetermined benchmarks.

We hope that this analysis will both inform and inspire the design of improved curated games in the future. A teacher of at-risk 7<sup>th</sup> graders wrote to us about how his students developed a newfound interest in science after playing Vanished. It is our hope to create more experiences like the one his students had:

My students learned how to work together to solve problems they knew nothing about to start with. They learned how to assimilate knowledge and then apply what they had learned. They learned how science really works! I had one student...who even became very involved in cracking the codes using all sorts of different methods. Every day he would come into class thrilled to tell me what he decoded and how he did it. I overheard a few student [sic] mention that they now want to be scientists when they grow up.

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## **Acknowledgments**

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# **Enhancing Introductory Programming with Kodu Game Lab in a High School classroom**

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**Abstract:** Kodu Game Lab is a tile based visual programming tool that engages students through playing and developing computer games to learning programming concepts. A series of exploratory investigative studies was administered to establish if student engagement with programming was enhanced through using Kodu Game Lab.

## **Introduction**

Engaging mainstream students in introductory programming lessons is a great challenge for Information and Communication Technologies (ICT) teachers (Guzdial and Soloway, 2002; Wiedenbeck, 2005). Guzdial and Soloway (2002) suggest that engaging students is critical to deep learning. With the advent of object-orientated programming languages like Alice (Dann, et al., 2009), Scratch (Meerbaum-Salant, et al., 2010), Game Maker (Overmars, 2004) and Kodu Game Lab (MacLaurin, 2009), there has been an increased interest in the value of these tools to see if and how these tools can improve student engagement. Moreover, these tools also represent the potential to increase student interest in computer science (Guzdial and Soloway, 2002). A computer game development tool presents students the opportunity to develop their own worlds rich in visual and auditory interactive content, thus inspiring and motivating students to create their own designs (Lawhead, et al., 2003).

## **The Study**

To evaluate the effectiveness of using Kodu Game Lab to introduce the programming concepts, an experiment involving students was conducted on a Year 9 ICT Literacy class in a New Zealand High School. The goal of this study was to measure the levels of engagement, enjoyment, and how much fun students felt they had while using this tool. The study was integrated into the existing class timetable and therefore the students had no choice in learning the materials (but could elect not to take part in the study). The students would receive one one-hour class per week for four weeks. As exploratory research this study was limited to ‘what people said’ and the option of developing and standardizing additional metrics was left open.

## **The Participants**

The study involved 19 participants aged between 14 and 15 years old. Of the total population, 68% were male and 32% were female. The majority (95%) of the class identified as being European/Pakeha (Caucasian) and the remainder identified as being Maori.

## **Methods**

To understand the students’ perceptions about programming, programmers and obtain demographic data students were asked to participate in a pre-exposure survey. To collect the perceptual and demographic data a five-point Likert scale was used. The Likert scale provided a very positive (5) response, a very positive response (5), a positive response (4), a neutral response (3), a negative response (2), and a very negative response (1).

Throughout the study the students underwent continuous structured observation by the class teacher and levels of engagement, collaboration, and peer teaching were observed—as were levels of boredom and frustration during each lesson. To ensure that the observed behavior was a result of the lesson and not other mitigating factors, the class teacher also provided a rating of any external factors. To collect the data the class teachers were given guidance and a class observation form with a three point Likert scale to measure each observed behavior for each student. The observation sheet included the definition and attributes of each behavior for observation.

## **Data Analysis**

The students ( $n=19$ ) reported moderate to high levels of enjoyment with 12% of students indicating high levels of enjoyment and 12% indicating they enjoyed the lessons. This represented a collective 32% of the students reporting an enjoyable experience.

The cumulative levels of observed enjoyment and engagement behaviors were moderately high. Table 1 shows the results of the observed enjoyment and engagement behaviors. Conversely, the levels of observed boredom and frustration by the class teacher were not high. Table 2 shows the results of the observed boredom and observed frustration behaviors.

Rating	Observed enjoyment %	Observed engagement %
1 (low)	3	6
3	29	9
5 (high)	71	89

**Table 1: Observed Student Behaviors – Enjoyment and Engagement.**

Rating	Observed boredom %	Observed frustration %
1 (low)	75	69
3	22	25
5 (high)	3	6

**Table 2: Observed Student Behaviors – Boredom and Frustration.**

The levels of collaboration and peer teaching were also observed. Table 3 demonstrates that both the amount of collaboration was high and peer teaching was moderately high.

Rating	Observed Collaboration %	Observed peer teaching %
1 (low)	3	6
3	57	60
5 (high)	40	34

**Table 3: Observed Student Behaviors – Collaboration and Peer Teaching.**

While acknowledging the limitations imposed by the design and execution of the exploratory study the measureable changes suggest that an object orientated education tool to introduce programming concepts to High School students provides motivational value. The concept fun was used by students to express satisfying learning experiences in a routine school class.

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# ***The High School Game:*** **An Intergenerational Board Game for Discussing Secondary School Stresses**

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**Abstract:** In contemporary society, the American high school experience requires students to strike a delicate balance between social and academic pressures. These students wrestle social issues while trying to meet academic requirements that prepare them for the world outside their secondary school microcosm. Typically teens are underprepared for these pressures and are left to face them alone. *The High School Game* is a solution that creates a safe discussion space for considering strategies for coping with these stresses and maintaining focus on academic achievement. The game exploits inter-generational play, supporting counselors and parents in critical exchanges with students.

## **Introduction**

The high school experience is a critical time in any teenager's life. It is a journey that paves the way for a person's future. Unfortunately, most students start that journey blindfolded with no preparation or expectations (Brodkey, 2010). They are suddenly facing social and academic issues with little knowledge or experience. Teenagers struggle with personal identity, peer pressure, stress from academics and dating (Ryan, 2000). The transition from middle school to high school has a particularly unique set of challenges (Akos, 2004). It is no wonder that these students struggle to achieve academic success.

Likewise issues of peer pressure and academic cheating have been experienced by parents and grandparents. A primary goal of this game is not to prescribe solutions to players, but to simply facilitate conversations between family, friends, counselors, mentors and pre-secondary students.

The philosophical approach to these challenges is that an appropriate balance of social and academic issues should aid student success. Instead of encouraging students to prefer social concerns over academic concerns, the designers understood the challenge as one of balance. It is true that there is as much social growth in these formative years (Akos), as there is academic growth. As such, the game is designed to offer a safe space in which to practice real world skills in harmony with game based learning patterns (Crawford, 1984). They also encourage experimentation; as such safe spaces insulate players from the risks of real world experimentation (Huizinga, 1955) and help students avoid repeating mistakes by practicing through play (Marango, 1999).

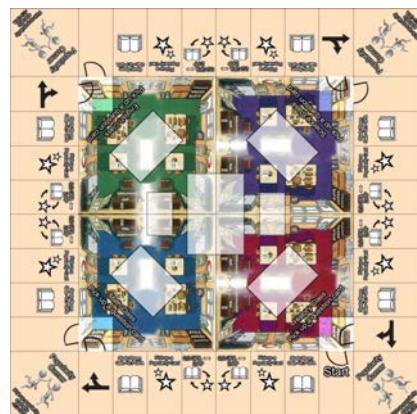
## **Game Design**

The team began by evaluating the United States secondary school experience commonly referred to as high school (grades 7-12 or grades 9-12). The design of the game translates those experiences into gameplay. The game is a turn-based experience for a minimum of two players and a maximum of 6. The primary goal of the game is to have the highest final score, calculated by combining academic points with popularity points. Players are given choices to achieve both types of points and they must balance the two to best their opponents.

Players take on the role of a student who just started high school. At game start, players must join a clique to determine their starting statistics for the game. For example, the jocks clique has high popularity points, while the nerds clique has high GPA. The obvious procedural rhetoric (Bogost, 2008) of joining a clique is mitigated by a simple design goal. The game's design demonstrates that the clique the player chooses doesn't matter; what really matters is how the game is played. The game does not bind the player to a clique; cliques demonstrate type labeling and offer players self-empowered movement beyond such labels. The play-balance avoids distinct clique advantage.

Once cliques are chosen, players proceed through the bulk of the game experience. Players move marker pieces around the board shown in Figure 1. Movement is managed by a roll of the dice, counting clockwise from the start position. Players are asked to answer age appropriate academic

trivia from four basic subjects: Math, Science, History and English. Correct answers to these questions improve a player's grade point average (GPA). The game concludes with a final exam, containing one question from each of the four topics.



**Figure 1: The game board.**

Social savvy is reported through a popularity points average (PPA). Popularity in high school is largely evaluated and determined by a student's peer group. As such, players are awarded popularity points by other players. Popularity points are awarded through the player's ability to debate. After each round, two players debate on topics ranging from sex to religion in schools. The remaining players listen to these arguments and award their limited points accordingly.

This play strategy demonstrates three primary benefits: it encourages players to think about socially relevant issues before they arise; it allows players to negotiate the social systems around consensus building; it encourages players to view multiple perspectives on relevant issues. Importantly, the third benefit emphasizes that these challenges of a young person's life are not to be met alone.

Parents, counselors, or other individuals who have matriculated out of college benefit from discussing these topics with young people before they happen. All players are practicing the ability to make claims relevant to the other players. Players are encouraged to formulate debates focused not on their own justifications, but on the other players' priorities, values and judgments. The novelty is that intergenerational conversations are reoriented toward same level discussions. Players are free to make claims based on their personal values and experience.

## Conclusion

*The High School Game* attempts to identify and address the challenges of high school life. The game focuses on finding the balance between social life and academics via exchanging ideas. Players young and old bring the experience of real life stress to a safe and consequence-free play space.

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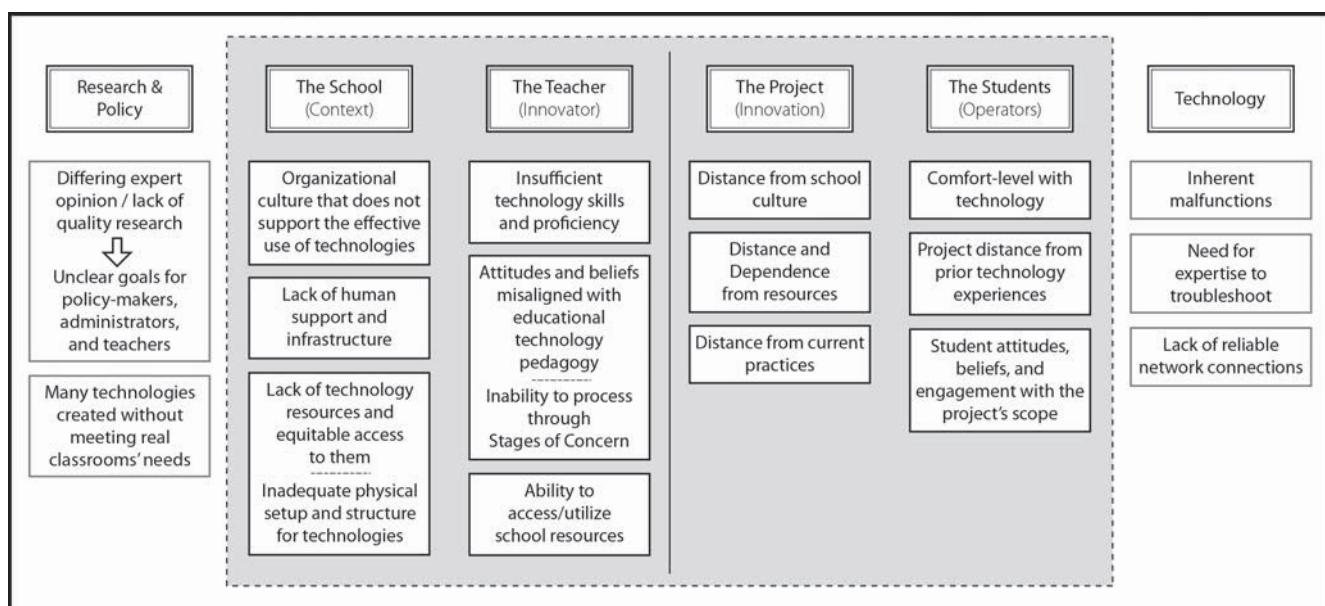
## “H”i5: Unblocking the barriers to learning games in education

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**Abstract:** One of the greatest challenges discussed in the field of educational technology is the difficulty in the successful adoption and implementation of these innovations in practice in the general classroom. Many beautiful games get developed, but few are used broadly in education. Research has teased out the various barriers to effectively integrating technology in the classroom. There is an array of reasons behind this lack of adoption, however many occur at the school and classroom level and can often be effectively mitigated if awareness and support are brought to the potential challenges—this is the goal of the i<sup>5</sup>. Game designers can use this framework to enhance their designs and marketing mechanisms to increase adoption, and educators can do the same to mitigate some of these barriers which can often thwart intentions to try new games and pedagogies in the classroom.

### Overview

The i<sup>5</sup> is an analysis and survey tool that assists teachers, school leaders, and researchers in the successful use of educational innovations. The i<sup>5</sup> helps in identifying and mitigating the barriers to innovation—particularly technology-based innovations—at varying levels of the educational system—from the individual classroom up to macro/national level. The i<sup>5</sup> was derived from a metasynthesis on the barriers to the integration of technology in education (Groff & Mouza, 2008); from this metasynthesis a framework (see Figure 1) and the i<sup>5</sup> tool were produced, which subsequently has been used in numerous settings including regional teacher professional development and the design of educational innovations and supporting programs (Klopfer, Osterweil, Groff & Haas, 2009; Klopfer & Haas, in press). This framework gives a basic overview to the potential barriers across the different elements of the system with each of these boxes representing very nuanced elements such as school cultures. Using this framework in context with a specific game, we can identify likely barriers and challenges to adoption in schools and offer suggestions on ways to overcome or mitigate these barriers in order to increase the game’s likelihood of adoption and scale. Those elements within the gray box inside Figure 1 are elements that can be influenced in this way (Groff & Mouza, 2008).



**Figure 1: The barriers to integrating technology-based innovations in the classroom.**

Each learning game can address likely barriers to adoption when considering the game’s design, but also post-production, by creating supports and mechanisms to reduce the barriers when teachers go to use the game (see Figure 2). The Learning Games Network has used the i<sup>5</sup> framework with various learning games developers—some of these examples will be fleshed out in the paper/poster.

The Innovation (Game)	The Context (Schools)	The Innovators (Teachers)	The Operators (Students)
<b>Distance from School Culture</b> – The extent to which the game deviates from general school culture and beliefs, and is dependent on more than just the teacher to succeed.	<b>Organizational Culture &amp; Support</b> – The extent to which school culture is supportive of the use of this type of innovation, through leadership, peer support/collaboration, and other school mechanisms	<b>Technology Proficiency</b> – Individual teacher aptitude, proficiency and comfort level with technology and new tech-based applications.	<b>Technology Proficiency</b> – Individual student aptitude, proficiency and comfort level with technology and new tech-based applications.
<b>Distance from Resources</b> – The extent to which the game requires new hardware and technologies to implement, and the teacher needs to have control over this hardware.	<b>Human Infrastructure</b> – The capacity of schools in regards to responsive technical staff, supportive administrators and other human capital resources	<b>Pedagogy-Tech Proficiency</b> – Attitudes/beliefs about learning via tech-based applications, and the degree of alignment of these with the pedagogy designed into the game.	<b>Project-style Experience</b> – The comfort level of the student with the role they must take during the implementation of the game (i.e. self-directed, collaborative, etc).
<b>Distance from Current Practice</b> – The extent to which the game/project is similar to previously implemented games/projects and/or pedagogies for this content.	<b>Technology Infrastructure</b> – The school's tech capacity in terms of access technology to support the game (i.e. computer labs, classroom computers, laptops, tablets, etc).	<b>Knowledge of Resources</b> – Individual teacher resources and supports, both within and outside the school, that support the game.	<b>Beliefs/Attitudes</b> – The attitudinal factors that vary greatly amongst students and will impact their performance with the game in the classroom.

**Figure 2: The potential barriers to address when using a learning game in the classroom.**

### The i<sup>5</sup> in Practice

The i<sup>5</sup> has also been developed into an Online Survey for individual teachers who seek to try a new learning game in their teaching. The tool prompts a teacher to reflect on questions to these elements in regards to their context and the learning game they want to use. When finished, the tool feeds back a brief report to the teacher, helping them identify likely challenges they will face and suggestions on how to overcome them. Ultimately, this data can be aggregated to help a school and/or district leader understand the common challenges to using game-based learning in their school/district, and plan supports and interventions for those areas. Likewise, this data can be aggregated at a supra level, to inform game designers and developers on ways to create supports with their learning games to improve adoption and integration in the classroom. For example, the i<sup>5</sup> has been used by the Learning Games Network to provide a market analysis of potential barriers to adoption and classroom integration of learning game developed by an external partner whose game was targeting financial literacy. Through this analysis, the game developer was able to create strategic supports and on-ramping mechanisms to increase the use and adoption of games by teachers, students, parents, etc.

A sample use case of a teacher using the i<sup>5</sup> to support his personal classroom practice would be:

*Mr. Smith has heard good things from colleagues who have used the game Civilization in their classrooms to teach the core unit of historical development and negotiation dynamics. He decides he wants to try this new approach this year in his classroom, but has little familiarity with games. A peer refers him to starting with the i<sup>5</sup> to help him in his endeavor. He takes the brief questionnaire the i<sup>5</sup> walks him through, and it identifies for him likely challenges he will run into; these include the Human Infrastructure in his school to support him in using this digital game, and Project-Style Experience of his students—as this will likely be a fairly new school experience for him. The i<sup>5</sup> also suggests some ways he can find supports and overcome these potential barriers: he lets his tech-savvy colleagues know that he's going to be implementing this game-based learning during a given week, and asks if they would be available during that time to answer questions and give support as needed; he also decides to do a mini experience that exposes his students to an immersive game-based*

*learning experience first, so they are more familiar with it before jumping into the full unit with Civilization. After the unit is completed, Mr. Smith decides to take the i<sup>5</sup> survey again to review what actual barriers and challenges he did encounter when he implemented the unit, so he can keep improving on them in the meantime before his next game-based learning endeavor.*

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# The *Lit2Quit* Mobile App: Evoking Game-based Physiological Effects that Mimic Smoking

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**Abstract:** Well-designed games are not only engaging and enjoyable, but they can also provoke cognitive and affective engagement that may promote behavioral change. This is in fact the mission of the *Lit2Quit* mobile game designers and researchers. Drawing on cognitive and behavioral change research, *Lit2Quit* has designed a health game with an innovative breath-control design element, which by mimicking the physiological and perceived effects of nicotine could help smokers reduce or quit their smoking habit.

## Introduction

Tobacco is one of the leading problems the world faces today. Although tobacco use may have decreased, it remains the leading cause of preventable death in the United States (RWJ Foundation, 2009). Among adult smokers, 68.8% report that they want to quit completely, and more than 52.4% tried to quit in 2010 (Malarcher, Dube, Shaw, Babb, & Kaufmann, 2011). Regardless of many available behavioral, physiological, and medical interventions, many smokers still struggle with quitting or reducing their smoking habits (Lancaster, Stead, Silagy & Sowden, 2000); thus, the necessity of new approaches to this problem is evident. Can a mobile game become an option for smokers to change their behavior and reduce their smoking habits? Incorporating breath as an innovative game control, *Lit2Quit* aims to mimic similar emotional and physiological effects as of smoking. Ideally, when smokers crave a cigarette, they can reach their pockets to play *Lit2Quit* instead of lighting a cigarette!

Breath therapy has been proven to be an effective intervention for reducing smoking habits (O'Connell, Hossein, Shwartz & Leibowitz, 2007). Breath therapy interventions for smoking cessation focus on guiding smokers in regulating their breath mechanism in a way that slows down the pace of their whole body and therefore promotes general relaxation (American Lung Association, 2009). Compared to other interventions, breath therapy allows greater scope for physiological effects and has been shown to be an effective intervention for smokers in other contexts since it mimics the physical behavior of smoking (O'Connell et al., 2007). However, a major drawback of breath therapy is the low motivation on the part of participants to continue the process. Thus, new approaches are needed to motivate smokers to persist in the intervention and to support them throughout the process. *Lit2Quit* offers an engaging game-play that could be an effective behavioral coping strategy, motivating smokers to adhere to the self-regulated process of smoking reduction, while providing similar physiological and perceived effects of smoking.

Research shows that smokers perceive smoking as a sedative or stimulating experience depending on their state of mind (Donovan & Marlatt, 2007). However, physiologically, nicotine is a stimulating substance that increases heart rate and raises the skin conductance level. Mirroring the perceived stimulating and sedating physiological effects of nicotine, *Lit2Quit* is designed in two modes, Rush and Relax. These modes use specific breath patterns and game-design challenges to either excite or relax the player, depending on the mode of the game.

The Rush mode of the game (see Figure 1.a) provides a stimulant effect through breath control, fast paced game-play, warm colors, and energetic sounds. Playing Rush, the player is on a mission to bring light to the galaxy by creating stars while avoiding obstacles in the universe. In connection with certain obstacles encountered during play, players periodically perform quick inhale and exhale cycles- called "Breath of Fire" (BoF). For each BoF, players exhale quickly and repeatedly with high pressure into the device's microphone. The frequency and duration of BoF, and number of breaths for each BoF are adjusted based on the player's natural breath rate and their level of expertise in the game. BoF has been proven (Gilbert, 1999) to stimulate the body, increases the heart rate, and to create a sensation of "light headed"—a feeling similar to stimulated effect of smoking.

On the other hand, the Relax mode (see Figure 1.b) provides calming effect through breath control, slow paced game-play, cool colors, and relaxing sounds. In this mode, the player is a speck of light and has the mission to gather stardust from the earth and bring it back to the sky. In order to control the movement of the stardust, the player breathes slowly and consistently during the 5-minute game-play. The game automatically adjusts the in-game breath rate to half of player's natural breath rate, measured prior to the game-play. Deep, slow, and consistent breath has been proven to relax the body and provides a sense of calmness (Courtney, 2009)—a feeling similar to sedative effect of smoking.



**Figure 1a: Rush mode of Lit2Quit**



**Figure 1b: Relax mode of Lit2Quit**

A review of experiments into color and emotions concludes that red colors are more physiologically arousing than blue colors (Valdez & Mehrabian, 1994). A combination of red color and loud sound in the game will lead to higher levels of arousal and perceptions of excitement; whereas a combination of blue color and soft sound in the game will lead to a calm and soothing experience (Valdez & Mehrabian, 1994). Accordingly, warm colors and energetic sounds are used in the Rush mode, and cool colors and soothing music in the Relax mode of *Lit2Quit*.

In this poster session, we will discuss *Lit2Quit* game design and challenges, present data confirming that *Lit2quit* partially mimics perceived and physiological effects of smoking nicotine, and talk about future plans to test whether *Lit2Quit* changes smokers' behavior long-term and helps them reduce their smoking. The hope is that smokers craving a cigarette reach for their mobile device to play *Lit2Quit* instead of lighting a cigarette!

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# **Student Perceptions: A Game-Based Achievement System in an Online Undergraduate Course**

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**Abstract:** We examined student perceptions of an achievement system used in *Adventures in Emerging Media*, a novel online course design that allows students to choose what topics they wish to learn in an attempt to acquire their dream job from a fictional media CEO. Modeled after the achievement systems used in contemporary video game platforms, this system rewarded students for completing both standard course requirements, as well as performance considered above and beyond minimal requirements. Students responded to Likert-scale survey questions asking them to assess how much of an impact achievements had on their effort and performance. Results indicate an overall positive response towards the use of achievements.

## **Background**

The ever-growing popularity of video games has spurred interest in their use in education. Gee's (2003) eleventh principle of what education can appropriate from video games is *Achievement*. Video games, Gee argues, contain rewards and achievements that also indicate the player's increased skill (2003). Video games as simple as Pac Man contain more intrinsic rewards than traditional schooling, giving players a sense of empowerment and increased skill within the game that educators should attempt to mimic (Squire, 2003).

## **Course Design**

*Adventures in Emerging Media*, offered online at the University of Central Florida, is a unique course designed with the explicit goal of targeting student motivation. Students were given an increased amount of autonomy and agency in several aspects of this course which included choices in modules and assignments, aspects that are analyzed in detail in other papers (Lindgren & McDaniel, in press). In an effort to help the instructor to encourage specific online behaviors that may not occur naturally in a course designed to encourage choice and agency, achievements were designed as control structures to promote productive and pro-social class activity. At the outset of the course, students were informed that an achievement system would be used, not only as a fun way to track individual accomplishments in the course, but also as a component of their participation grade.

Achievements were stored on individual student pages within the course website and can be categorized into two types: visible and hidden. As the categories indicate, students were able to see the visible achievements prior to completing them. The hidden achievement badges only became visible after a student completed the required tasks to obtain these achievements. Because students could at any time compare their achievements with those of another classmate, theoretically, once one student had acquired a hidden achievement, it became visible to all other students comparing their achievements to those of the student who had obtained it.

Styled to look like plaques, the achievements were given interesting titles and graphics (Figure 1). Student achievements were displayed in a grid format on the student's course page (Figure 2). Five visible achievements were received automatically for: posting a required student introduction on the course discussion forum, successfully completing the first three weeks of the course, successfully completing two-thirds of the modules, successfully completing all required modules, and turning in the Week Twelve Milestone for the Final Project. The course also included six hidden achievements for: being the first person to post a project each week, answering a peer's course-related question on the discussion forum, turning in a project with exceptional detail or technical skill, completing three modules for one week (rather than just the required one), completing four modules for one week, and for watching at least some of the video contained in each module for a given week. These hidden achievements, especially, were designed to reward students for exploring additional course content and performing tasks that increase their quality of learning, such as revisiting previous weeks' material, engaging with peers, achieving higher levels of mastery, and using their time more effectively (such as taking a quiz early). These are behaviors in which naturally intrinsically-motivated students intuitively engage; the assigning of extrinsic rewards to these activities was done with the

anticipation of teaching less motivated students that these behaviors can be beneficial, reinforcing these behaviors in students innately performing them.



**Figure 1: Example Achievement Badges.**



**Figure 2: Achievement Grid.**

## Student Perceptions

It was our expectation that these achievements would operate in a similar manner to reward systems in video games, prolonging student engagement, increasing motivation, and providing satisfaction in accomplishments. One way to assess the effectiveness of these goals is to directly ask students for their opinions. A total of 138 students enrolled in the Adventures in Emerging Media course during the Fall of 2011 completed an online survey upon the completion of the course. Students were asked to use a Likert-scale from one to seven to self-evaluate the impact that the course's achievements had on both the effort they put forth in their course assignments as well as their overall performance in the course. An additional limited-response question on this survey asked students to indicate their primary motivation to obtain achievements during the course.

The Likert-scale responses were averaged and suggest a generally positive response to the course achievements. Students agreed most strongly, with an average of 4.78, with the statement indicating that they believed the achievements were realistically obtainable. Students averaged an agreement level of 4.14 in response to the achievements having a positive impact on the course. While these levels lean toward a generally positive perception of the awards system, they are lower than might be expected. This was likely the result of frustration about the hidden achievements being difficult to identify. This was confirmed in a small-group interview at the end of the semester where participating students expressed discomfort with having a component of their grade tied to rewards that were not always apparent. On the limited-response question, 48% of students specified that their acquisition of achievements was motivated by the impact of achievements on their grades. Nine percent indicated that they earned the achievements in an attempt to improve the perception of their work by the instructor, and, 8% attributed achievements to the perception of their work by their classmates. Interestingly, females responded more favorably to achievements, averaging .68 higher on the Likert scale than their male peers. Finally, 15% of students indicated that they wanted achievements but could not articulate their exact motive for doing so, and the final 23% of students claimed they were simply not motivated to earn achievements. These results indicate that game-based achievement systems show potential for use in formal university courses as one method of student motivation and deserve further study and, perhaps, alternative implementations.

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# This is Not a Game: Alternate Reality Games as a First Year Composition Course Structure

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**Abstract:** In this paper, I will explore the theoretical educational use of alternate reality games (ARGs), a genre that relies less on computer interfaces and focuses more on “real world” spaces. Specifically, I will explore the use of ARGs as a course structure for student production of texts in the First Year Composition classroom. I will focus on two specific writing programs in which I have taught—a four-year university (UW-Milwaukee) and a two-year technical college (Gateway Technical College)—and use constructivist learning principles for ARGs set forth by Whitton and Hollins (2008), composition theory, and transmedia theory.

## Introduction

A great amount of research is available on the use of several types of video games for educational purposes, but, unfortunately, far less is available on the potential and impact of Alternate Reality Games (ARGs). ARGs use “real” world features and artifacts, such as streets, buildings, public spaces, or pay phones, and publicly available media, such as billboards, posters, or media made available through mobile networked technology. ARGs tend to use multimedia clues to direct players on a narrative-driven puzzle-solving experience that takes place in the players’ “real” world. A standard definition of the genre is still elusive, at least partially due to the numerous combinations of complexities and variations offered by the relatively simple structure of the ARG and the multimodality of its narrative/gameplay environment: interactive web-based technologies, DIY publishing, remix and the co-option of popular narratives and artifacts.

For this paper, I will adopt Jane McGonigal’s definition of an ARG:

an interactive drama played out online and in real world spaces, taking place over several weeks or months, in which dozens, hundreds, thousands of players come together online, form collaborative social networks, and work together to solve a mystery or problem that would seem impossible to solve alone (2004).

A few translations that might help the reader see a more concrete connection to this paper—bringing an ARG into a multimodal composition classroom. First would be to think less of the “drama” (or, the fictionalized impetus for entering the game; the reason to play). I encourage the reader to focus on the “interactive” pursuit of a community of student “players” to analyze and interpret texts collaboratively—the act of interpretation being akin to “solv[ing] a mystery or problem,” though one with an open solution. Further linking the composition classroom to this definition is the language of the assignment sequence —language that positions interpretation as an act that may seem incapable of being achieved alone, without the reflection and multiplicity of perspectives that the composition classroom provides.

The question I will try to address here is: how can an ARG serve as a pedagogical tool in the composition classroom? Furthermore, while ARGs have been used as texts for academic study in media studies classrooms, my aim is to apply the knowledge from the above approaches to illustrate how an ARG might serve as a structure for motivating and producing student writing within the goals of two specific first-year writing programs in which I have taught: Gateway Technical College (GTC) and the University of Wisconsin-Milwaukee (UWM).

## Why ARGs

Nicola Whitton and Paul Hollins position the collaborative environment of game worlds for constructivist education models (2008). Citing P. C. Honebein, constructivist collaborative learning environments should:

encourage students to take responsibility for their learning, including what and how they learn; provide multiple perspectives; create self-awareness of the learning process; make learning relevant and authentic; make learning a collaborative and interactive social experience; and use multiple modes of representation and rich media (Whitton and Hollins, 2008, p. 222).

In my discussion of ARGs in the context of the GTC and UWM programs, I will adopt these principles, as these philosophies are at the heart of these programs, asking students to collaborate and value their learning in and out of the classroom.

One approach to understanding the educational promise of ARGs is to look at a related study of transmedia narratives, as students are already employing collective intelligence communities to interact with “texts” and form individual and collective meaning through collaborative production outside of the classroom. In *Convergence Culture*, Henry Jenkins discusses the educational potential for collective intelligence communities in terms of fan cultures. Jenkins sees the reading of transmedia narratives by collaborative intelligence communities as one way in which individuals and groups can interpret and construct meaning (Jenkins, 2008, pp. 3-4).

In “A Pedagogy of Multiliteracies,” The New London Group (2000) makes a similar argument for the relevance—and need—for multi-modal pedagogies in the composition classroom. Their claim is tied to the changing nature of networked technology-facilitated communications that can span cultures and subcultures, nations and socio-economic categories, as well as to the collaborative structuring of the corporation in an era of fast capitalism. The critical engagement with this type of narrative within the FYC classroom can encourage our students to develop a more critical new media literacy: reading/writing/resisting multimodal rhetorics and representations.

To return to what is more immediately related to FYC practices, specifically the act of interpretative writing, troubling definitive authority—whether in texts or in pedagogical roles—is not new to composition theory. In “Reading” from Jeffrey Nealon and Susan Searls Giroux’s *The Theory Toolbox* (2003), the authors approach interpretation through the lens of the death of the author. They discuss active interpretation as a reversal of “a passive consumption model (the reader consuming the author’s meaning)” and a resultant “freeing up of multiple points of view—as many good readings as there are readers” (p. 21). They are quick to point out the danger in a simple reversal, however: “If we’re not careful, the absolute control of the author can give way very quickly to the absolute control of the reader, who then usurps the author’s role in the *game of meaning*” (p. 22, emphasis added). To achieve some middle-ground between these, the authors situate interpretation as “a process of negotiation among contexts,” mediated by language, which is, in turn “a social system of meaning” (p. 23- 25). The ARG is, by definition, reliant on community participation (or, “a social system”), which makes it particularly suited to a composition classroom concerned with creating a space for multiple interpretations.

When conceptualizing an ARG in terms of an assignment sequence, I turn to David Bartholomae's “Writing Assignments: Where Writing Begins” (1982). Bartholomae engages with ideas on how to create a space for students to enter into a discourse in the composition classroom. In asking how a student might “invent the university when he sits down to write,” Bartholomae finds relevance in allowing students to form or even approximate discourse communities for the basis of discovering knowledge through repetitive and slowly expanding writing practices. The benefit of using ARGs as a platform for ludic pedagogy is that they do not require the mastery of CG-mediated virtual spaces.

Furthermore, facilitated by Jenkins's discussion of ARGs as a form of transmedia narrative that elicits collective intelligence and the production of meaning, the transmedia nature (or multimodality) of ARGs also frequently encourages texts to be viewed in intertextual and hypercontextual ways. That is, in assembling meaning from a variety of texts or from various sections of the same text, players make interpretative “moves” to frame and juxtapose different texts, narrative threads, and contexts in terms of others. Perhaps most easily recognized in these “moves” would be the academic writing technique of framing: a player might understand one text by means of analyzing another. This intertextuality/hypercontextuality might also serve as a way into accessing the “what matters” to a writer and reader, a common way to understand a text’s purpose. The intertextual interpretative move might be seen as the player searching through their database of texts that already matter to them, texts that have remained with them because they had an impression on them. By speaking in terms of something that already holds meaning for them, a player might be able to better articulate—or at least approach—this notion of what matters in a text, and why that might be important to the writing they produce.

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# **Summer Game Camp: Modding a SMALLab Systems-Thinking Game**

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**Abstract:** SMALLab Summer Game Camp 2011 took place over two weeks, where 20 middle-school kids modified a systems-thinking game intended for use in a high-school classroom, using their own metaphors and game mechanics (narrative, images, sound). We believe that allowing kids to modify games helps them to develop high-level system thinking skills, and prepares them to be successful in our algorithmically driven world. The kids move from merely being players and consumers towards reinventing the game as designers, and create innovative story lines and characters, shifting the representational plane away from the original game's learning goals. They demonstrated their high-level thinking when describing their design choices in our daily group presentations. Our research on embodied learning in SMALLab indicates that learning about systems and participating in closed-system simulations in a collaborative & embodied, mixed-reality computer mediated environment, helps them understand systems experientially. Although much of the previous research in SMALLab has focused on formal learning, this paper is intended to share how it can also be used as an informal learning space.

## **Introduction**

The Situated Multimedia Arts Learning Lab (SMALLab) is a mixed reality learning environment, and an educational platform that engages the user through the use of sonic, visual and kinesthetic interaction and feedback. It is an embodied environment that requires the user to physically move through the 15x15 foot space, and is able to track up to 4 users with up to 12 motion sensor cameras. Students are able to collaborate and build knowledge in this space and research results have indicated a significant improvement in test scores when including SMALLab in formal (classroom-based) instruction. (Birchfield, 2009; Johnson-Glenberg, 2009; Birchfield, 2010; Johnson-Glenberg, 2011) For the past five years, members of the SMALLab research group at Arizona State University have also taught a summer game camp, where participants have ranged in age from 8-18. The goals of the SMALLab Summer Game Camp are aligned with the learning goals of GameStar Mechanic (providing an environment that teaches kids how to design video games as a form of system thinking through 21<sup>st</sup> century skill building exercises) and integrated the three major components of GameStar Mechanic games: Play, Design, Share. In this case, it was an accelerated 2-week period (35 hrs). On day 10, the 20 kids presented their games to friends and family, and all had a chance to play the games. Campers' ages ranged 10-13 ys., with diverse ethnicities and economic backgrounds.

## **Game Modding**

The term "modding" has been used by the gaming community to describe when players or users make modifications to technology, either hardware or software (Ito, 2010). Here this word refers to designing new interface elements and game levels. One conceptual model for understanding different types of mods classifies them into 3 categories: alteration, juxtaposition and reinvention, according to Salen and Zimmerman (*Rules of Play*); reinvention sits at the intersection of alteration and juxtaposition, as it affects form and context by changing the game's representation and interactive structures. Some believe that game modding has the potential to foster highly engaged learning by tapping into the natural passion of students for making video games because the process of creating a good video game requires a complex set of skills that maps closely to key competencies (Gershenfeld, 2011). According to the "Pew Research Center's Internet & American Life Project," more than half of all teens are currently creating, modding, and mashing up media content ranging from videos to music to blogs. As the tools for video game creation are becoming more accessible, an increasing number of the 97 percent of teens that regularly play video games now want to make video games. (Lenhart and Madden, 2005).

## **The Camp Format**

Camp lasts two weeks, or ten days, for four hours per day and takes place in the SMALLab at Arizona State University. On the first day of camp, campers typically fill out worksheets that prompt them to share their knowledge or understanding of certain game design principles such as: *What makes a good game? What is flow? What is an example of a game mechanic? Etc.* They also fill out these

same surveys out at the completion of game camp so that we might compare the two to see how much they have learned, and also consider the complexity of the responses. The first few days of camp are spent playing simple non-technology games and board games, designing rule sets for these games collaboratively, while having discussions and sharing insights about game mechanics and user experience. Next, the SMALLab mixed-reality learning space is introduced to the kids, and time is spent building knowledge about systems, using the SMALLab infrastructure as a model. Then the kids split into teams of 3-5 per group and they begin to design their games (genre, main character, narrative, and create audio and visual assets). Once teams have come up with a concept to modify the template, they move into the computer lab to begin creating their assets for the game. Counselors taught students how to create, find, and modify digital images; and also taught them how to record or find, and then modify digital audio to create sound effects. Teams also took turns working in the SMALLab space, under the supervision of a camp counselor and added their images and sounds, and also play-tested their games. The counselors challenged the students to consider how embodiment was being used in their game play. Each team developed three levels for their game, with each increasing in difficulty and complexity. Finally, on the last day of Game Camp, friends and family were invited to an Open House, where the teams would showcase their games and allow everyone to play the games in the SMALLab space.

### The Game Template

The game template that was used for the camp was a derivative of a SMALLab simulation that had been used in a high school classroom. The simulation, designed collaboratively with a science teacher, was designed to teach students about disease transmission and its misconceptions in a closed system; and to encourage system-thinking skills to discover the cause of the outbreak in the game. A description of the first year study can be found in last year's GLS proceedings (Johnson-Glenberg 2011). The simulation consisted of a modifiable amount of characters in the periphery of the space, and a medicine supply and water supply in the middle. Players could interact and replenish the health and water level of each character. The original simulation was ported from Java into Unity3D, and a version was created to allow kids to easily modify the images and sound effects by dragging and dropping assets into a folder.

### Results & Discussion

At the end of the workshop, the students presented their projects to family and friends. It is interesting to note the social dynamics of the group, where kids that probably would not have interacted in their school setting were working together and supporting each other through the game development process. The other is that the final game styles were all different and demonstrated through the design as well as language used during presentations, that they had gained a better understanding of systems by creating their own variations of one. One team modified the original game so that the characters became boats and cars; water supply in the middle of the space represented Fuel, and thus the energy disc surrounding each player represented a diminishing fuel supply. The medicine repository in the center represented Repairs, so that when the avatars from the original simulation were "sick" they were repaired.

### Conclusion

As this was the fifth year of the summer game camp, there are indeed lessons to be learned for the design of embodied games in a technology-enhanced embodied-learning mixed-reality space such as SMALLab & FLOW. With the advent of the Kinect in educational games on the horizon, there is much to be gained in further developing the model of game modding in informal spaces.

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# Why do Players Keep Playing?

## A Formative Analysis of the Motivational Qualities of Video Games and their Relation to Critical Success

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**Abstract:** This study examined the use of motivational strategies within video game instructions. A coding scheme based on the ARCS model was used to examine 5 highly-rated (HR) and 5 low-rated (LR) games. Results showed that games are indeed using ARCS strategies, and suggest that HR use more than LR games.

### Introduction

Video games have become a fixture within popular culture, and the field of serious games has led to explorations of the use of this medium to bring about positive outcomes. Scholars have especially been enthusiastic about the use of video games to facilitate education, and research has demonstrated positive effects on student motivation (Tüzün, Yılmaz-Söyli, Karakuş, İnal, & Kızılkaya, 2009), engagement (Annetta, Minogue, Holmes, & Cheng, 2009), and learning (Papastergiou, 2009). Because of these outcomes, it would be valuable to identify game factors that may contribute to engagement and subsequent positive player effects. One factor that has deserves research attention is how games teach players the skills that they need to play, as this often requires significant learning.

An ideal place to start from when examining this phenomenon is the ARCS model (Keller, 1987). ARCS describes strategies for designing motivational educational materials that are grouped into four categories: *attention*, *relevance*, *confidence*, and *satisfaction*. This study is a preliminary content analysis based on ARCS that examines the instructional materials contained within highly-rated (HR) and low-rated (LR) entertainment video games of 2010. The following research questions are posed:

- RQ1: How do video games' instructional materials encourage attention in players?
- RQ2: How do video games' instructional materials establish relevance for players?
- RQ3: How do video games' instructional materials encourage player confidence?
- RQ4: How do video games' instructional materials facilitate player satisfaction?
- RQ5: Is there a relationship between the presence of motivational elements within instructions and the critical ratings of video games?

### Methods

This study utilized content analysis to examine in-game instructions. The inclusion criteria, intended to keep design factors constant across games, were as follows: XBOX360, disc-based, and narrative-based games. Games with prequels released within five years were excluded, as sequels may rely on skills taught in previous games. Ten games (see Table 1) were chosen by selecting the first five and last five games that met the criteria from the ranked list of 2010 games on Metacritic.com (CBS Interactive, Inc., 2012). The coding scheme was based on motivational techniques that foster the four ARCS components: attention, relevance, confidence, and satisfaction (Keller, 1987). Simultaneously, to ensure the same gameplay was observed, two coders coded the first 45 minutes of the games for the presence of such techniques. Reliability was assessed on the whole sample, and percent agreement was calculated because the small number and yes/no questions inhibited the calculation of more rigorous assessments. The final questions included in the coding scheme had 80% or higher agreement. Differences between coders' responses were addressed by choosing one coder's response at random in order to avoid potential bias. After the games were coded, frequencies were assessed and the number of observed motivational techniques were added up to calculate each games' motivational score, which had a maximum of 17 and a minimum of -1 (due to reverse coding).

### Results

Overall, the only *attention* strategy (RQ1) used often by games was varying the format of instruction, such as using both text and graphics, which occurred in 70% of the sample. Two attention strategies were used by only one game each: using humor, and encouraging further inquiry or problem solving. In terms of encouraging *relevance* (RQ2), all of the games stated the intrinsic value of a new skill by explaining its present value without referring to future goals. Additionally, 70% of games stated the future usefulness of a particular skill, while another 70% met achievement striving needs by allowing players to master new skills in low-risk environments. The relevance strategy used least frequently

(20%) was providing choices for players in terms of how they learned skills. Many games facilitated *confidence* (RQ3) by communicating learning requirements (70%) and making positive player attributions for success (70%). However, only one game managed players' expectations for success by stating the likelihood of succeeding given a certain amount of effort. In terms of *satisfaction* (RQ4), 80% of the games utilized the following strategies: allowing players to see the consequences of their actions in a natural setting, providing frequent reinforcements for new tasks, providing intermittent reinforcements for already-learned tasks, and avoiding the use of threats. None of the games provided unexpected rewards for learning.

On average, HR games had higher motivational scores than LR games (see Table 1). Certain strategies were used markedly more often in HR games than in LR games, such as providing concrete examples for new skills (80% vs. 20%), employing modeling in teaching new skills (60% vs. 20%), providing frequent reinforcement for new tasks (100% vs. 60%), and providing intermittent reinforcements for already-learned tasks (100% vs. 60%).

<b>Game title</b>	<b>Motivational Score</b>	
<i>Highly-rated games</i>	Red Dead Redemption	11
	Bayonetta	10
	Alan Wake	8
	Vanquish	13
	Darksiders	8
<i>Low-rated games</i>	MegaMind	10
	MorphX	5
	Prison Break: The Conspiracy	8
	Quantum Theory	8
	Naval Assault	6

**Table 1: Games analyzed and associated scores**

## Discussion and Conclusion

Overall, these results demonstrate that games are taking advantage of motivational strategies, particularly in terms of relevance and satisfaction, in teaching players how to play. Additionally, they suggest that HR games use more motivational strategies than LR games. This implies that games that emphasize helping players to learn skills are seen as more appealing and, consequently, may garner more playing time. Yet, these results must be interpreted with caution. This study was formative, using a small sample with descriptive statistics. It was also focused only on short-term motivation, and did not capture potential long-term effects. However, the results, especially the differences found between HR and LR games, suggest that a study with a larger sample would yield valuable information regarding the relationship between motivating players to learn game skills and games' critical appeal. This has important implications for the development of serious games, which presumably can only bring about positive outcomes if players are engaged and motivated. This study suggests that the ARCS model may help developers to reach that goal.

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# Game Design and Social Media in a Middle School Classroom

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**Abstract:** Game design programs are becoming more common in middle and high schools. The Globaloria program, which combines game content research and media literacy with computer programming and game design in a social media setting, is used by thousands of students in several states. This paper presents qualitative and survey data from students at one charter middle school where all students participate in the program daily. Early results from a longitudinal study show some promising increases in student self-efficacy with regard to their ability to solve technological problems in the Globaloria classroom.

## Research Methods and Procedures

The presenter is an educational researcher who is based at a charter middle school that primarily serves low-income, minority students. All students at the school are enrolled in Globaloria, a game design and media exploration course that is both a social media platform and a game design-learning curriculum. This longitudinal research project follows cohorts of 6<sup>th</sup> graders, who will continue to take the Globaloria course daily each school year through 12<sup>th</sup> grade. The research question explored here is 'Does engaging in the Globaloria program increase students' self-efficacy with regard to solving technological problems?' The participants were two cohorts of students, (a) 6<sup>th</sup> grade students who are in their first year at the charter school and in the Globaloria course and (b) 7<sup>th</sup> grade students who are in their second year at the school and in the Globaloria course, were administered a self-efficacy survey four times over the course of the 2010-2011 school year. The research-based 11-item survey (Bandura, 2005), was designed to measure three dimensions of students' self-efficacy in the Globaloria classroom: (a) academic/technology, (b) social support for learning, and (c) self-regulation for learning. For each item, students rate their level of efficacy on scale from 0-100. Students also participated in one-on-one interviews about their work, ongoing classroom observations, and reflections about their game-design work on a blog, the results of which offer qualitative insight into the growth of technological self-efficacy, pre- and post-program surveys, school attendance and state assessment data. A literature review of middle school student self-efficacy in relation to career and educational aspirations will be available at [worldwideworkshop.org/reports](http://worldwideworkshop.org/reports) (Minnigerode, in press)

## Results with Discussion

Table 1 presents the average change in student reported self-efficacy on the technological subscale from the beginning of the year (Time 1) to the end of the year (Time 4) by grade level cohort and gender. Although all students showed increases in almost every aspect of technology self-efficacy, the students in their first year of the program (the 6<sup>th</sup> grade cohort) reported less change from the beginning of the year to the end of the year than did students who were in their second year of the program (the 7<sup>th</sup> grade cohort). The researcher hypothesizes that this is because 6<sup>th</sup> grade students, who are new to the Globaloria class, may overestimate their ability to solve technological problems in comparison to students who already have been in the course for a full year.

	6 <sup>th</sup> grade girls (N=44)			6 <sup>th</sup> grade boys (N=45)			7 <sup>th</sup> grade girls (N=44)			7 <sup>th</sup> grade boys (N=42)		
	T1	T4	change	T1	T4	change	T1	T4	change	T1	T4	change
How confident are you that you can...												
figure out new things about editing the wiki	75.3	78. 1	+2.8	82.4	77.6	-4.8	72.8	87.4	+14.6	74.6	80.6	+6.0
put your thoughts and ideas into words that are easy for people to understand on your blog	83.5	84. 0	+0.5	72.3	79.7	+7.4	72.7	84.8	+12.1	75.8	84.0	+8.2
figure out what to do when you get stuck on something doing Flash	71.4	79. 1	+7.7	73.3	77.0	+3.7	61.5	83.8	+22.3	65.0	80.6	+15.6
search on the Internet to find help when you get stuck on	77.0	74. 9	-2.1	81.8	87.3	+5.5	74.9	84.8	+9.9	75.7	84.0	+8.3

something											
Overall change			+2.2			+3.0			+14.7		+9.5

**Table 4: Average change in technological self-efficacy items from the beginning of the school year (T1) to the end of the school year (T4).**

Students also discuss their self-efficacy in written narratives. Table 2, below, summarizes student blog entries about their confidence as game programmers. Each of these comments has to do with students' experiences using Flash.

<b>Sixth grade boy:</b> <i>The hardest thing about the game design was the codes I had no idea where to put most of them. I'm proud that I finished this game and I made it fun. May 16, 2011</i>
<b>Seventh grade boy:</b> <i>I have learned how to use flash very well so far but not a master. I can improve a lot this year in many ways like learning how to use the jumping code on flash because that thing confuses me! May 23, 2011</i>
<b>Sixth grade girl:</b> <i>It was so hard getting the game to work and finding the codes to make it work. Even when talking with the group and choosing what we wanted in the game. I learned that my way is not always the right way. May 16, 2011</i>
<b>Seventh grade girl:</b> <i>I have learned to put almost every code in flash perfectly without struggle. May 23, 2011</i>

**Table 5. Student blog entries about programming in Flash.**

Evaluation of student work, classroom observation and interviews provide further rich detail about student experience as programmers. (See Figures 1 and 2 below). Research to align these sources is ongoing and publication of a more complete synthesis is forthcoming.



**Figure 17: Student prototype**



**Figure 2: Student interview "There is a whole lot of different things I am doing in Flash...."**

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# Playing Nice: Social and Ethical Reasoning Across In- and Out-of-Game Contexts

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**Abstract:** This study examines whether adolescent videogame players maintain the same values and ethical priorities in game spaces compared to their home lives. We presented a group of adolescent *World of Warcraft* players, a MMO game in which the participants play together to accomplish shared goals, with ethics-based scenarios to determine whether there is a difference in their values in game play compared to out-of-game. Our results indicate that adolescent players are more willing to abdicate control to authority in the context of the game, whereas they are more assertive about their personal rights in a home-based context.

## Online Game Play and Social Interaction

In MMO games, participants inhabit a designed, virtual world that contains both non-player characters created by the game designers and avatars controlled by other players. This creates a *mangle of play*, which Steinkuehler describes as the mangling of designer and player intentions (2006). Thus, much of the climate and culture of each of these games is shaped by the people who inhabit the world. Additionally, players may join with other groups of players to form alliances where they work collaboratively on tasks that are too difficult for any individual player. These groups, called guilds, often develop and negotiate their own group rules, which members of the guild must adhere to in order to participate. The culture of guild groups is participatory (Jenkins, 2006) and multiple intelligences (Gardner, 1999) are valued in these spaces, coalescing into a group-wide collective intelligence (Levy, 1999).

We are particularly interested in adolescents and how the social interaction that players experience through online play in these games shapes how they develop ethical and social reasoning skills. Though research has shown that these spaces teem with ethical norms where guidelines of behavior are emergent (Taylor, 2006) and are determined by the affinity group, we know little about how adolescents think and reason about ethical issues as they engage in online play. Participation in social games means negotiating between game rules and norms from other contexts including home and school. How is teenagers' reasoning about such issues similar or different across the two contexts? Does context matter in teenagers' ethical decision-making?

## Study Overview

This paper details a pilot study examining whether teen players of *WoW*, maintain the same values and ethical priorities in the context of the game as they do in their home lives. Our study seeks to better understand how adolescents think about ethical concerns in terms of competing priorities, including duty to authority, personal rights, promises, and personal relationships. We presented 14 participants with two separate scenarios, one about a home-based context and the other about a game-based context, and then examined their responses on a set of questions to infer their ethical values across the two contexts. One scenario, the out-of-game scenario, was adapted from a standardized scenario used on the Defining Issues Test, Version 2 (DIT2) measure of developmental ethics (Rest, 1979; Rest, Navaez, Thoma, & Bebeau, 1999) derived from Kohlberg's approach to morality (Kohlberg, 1976; Colby et al., 1987). The other scenario, the in-game scenario, we crafted to be structurally similar to the first but contextualized within the game world. Quantitative and qualitative analyses of their responses reveal differences in ethical reasoning across the two contexts.

## Methods

### The Casual Learning Lab

This study was conducted as part of a larger, two-year line of inquiry exploring the impact of a game-based casual learning lab on adolescent boys' literacy and learning. All participants were male and between the ages of 13 to 18, coming from both urban and rural communities. The goal of the afterschool program was to leverage the boys' existing interest in videogames to strengthen their

interest in literacy as a tool for problem solving, researching online information resources, and synthesizing in-game and out-of-game information.

### The Social-Ethical Reasoning Study

The questionnaire form, adapted from the standardized work on developmental ethics (Kohlberg, 1976; Colby et al., 1987) for each scenario was based on the DIT2 measure (Rest, 1979; Rest, Navaez, Thoma, & Bebeau, 1999) and designed to elicit information about participants' priorities regarding the ethical situations presented. Each item on the questionnaire asked participants to rank the relative importance of one of several competing interests in the scenario on a standard 5-point Likert scale and to give a short written explanation for each ranking. Questions for the two scenarios were parallel, allowing for comparison of relative rankings and rationale across the two contexts. The qualitative data, derived from the written explanations that the participants provided about their rankings, was coded for relevance to four identified ethical issues likely to be encountered by youth on a daily basis: duty to authority, personal rights, promises, and personal relationships.

## Results

Paired *t*-test comparisons revealed significant differences between the in- and out-of-game scenarios in terms of how the participants ranked the importance of authority and personal rights. Respecting the wishes of an authoritative figure was significantly more important to participants in the context of the game scenario ( $M = 4.14$ ,  $SD = 1.17$ ) compared to the real world scenario ( $M = 2.36$ ,  $SD = 1.01$ ), with  $t(14) = 4.69$ ,  $p = <.001$ . Likewise, the issue of one's own personal rights was significantly less important to participants in the context of the game scenario ( $M = 2.64$ ,  $SD = 1.28$ ) than in the real world scenario ( $M = 4.21$ ,  $SD = 1.21$ ), with  $t(14) = 2.96$ ,  $p = .01$ . Qualitative analysis of participants' written explanations corroborated the quantitative findings.

## Discussion

Our findings suggest that, in the context of MMOs, adolescents have different priorities in reasoning through social ethical dilemmas than they do in real world scenarios. Specifically, in-game contexts, teenagers appear more willing to abdicate control to an authority and are less committed to declarations of personal rights. Together, these findings suggest a pattern in which it appears that individuals are more willing to suspend personal rights and follow, at least temporarily, a designated authority than they are in out-of-game scenarios. The pattern is evocative of Jenkins' (2006) work on participatory cultures and Levy's (1997) theory of collective intelligence in that the suspension of individual rights in exchange for participation in the group collective, guided by the authority of an individual or goal or the group itself, is indeed a prerequisite of sorts to collective social movements. Such findings make sense: MMOs like WoW are based on a group mechanic in which individual players join collaborative groups of various sizes and agree to play by certain rules and norms.

Jenkins (2006) notes that feelings of empowerment among youth come from making meaningful decisions within a real civic context. We argue that one of the reasons why our participants showed a greater willingness to abdicate control and make sacrifices to individual achievement in favor of the best interests of the group is that in game contexts, players are active participants in the creation of group rules and norms. At home, parents are the authority figures and do not need to consult their teens about the household rules. The agency afforded to players in game contexts renders decisions meaningful and fosters critical ethical reasoning and reflection (Simkins & Steinkuehler, 2008). Having an active role in the negotiation of ethical norms would seem to support a willingness among adolescents to put the interests of the group ahead of individual rights and wishes.

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# Not Just for the Love of the Game: Finding Professional Quality in Game-Based Wikis

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**Abstract:** User-created wikis around popular videogames function as affinity spaces (Gee, 2004) and sites of participatory culture (Jenkins, 2006), forming a constellation of literacies (Steinkuehler, 2007) and information (Martin, 2011) around the game. In previous research on wiki editors, we determined that many contributors hope to leverage their experience to gain entry into professional industry positions. The question we address in this paper is whether the content created by these editors is comparable to the professionally published guides around games. Based on lexical and Coh-Metrix analyses of game-based wiki texts, our findings would suggest that the texts themselves do stand up to professional texts.

## Game-Based Wiki Communities

User-created wikis around popular videogames offer a space for fans to collaboratively create a resource used by the entire community. Players collaborate to pool their collective knowledge in a single organized space, acting as an asynchronous and persistent information resource. These communities function as affinity spaces (Gee, 2004) and sites of participatory culture (Jenkins, 2006), forming a constellation of literacies (Steinkuehler, 2007) and information (Martin, 2011) around the game. Functioning through strictly enforced cultural norms, when users add information to the wiki, it is checked for accuracy; writing style is critiqued and edited; and speculation is reserved for forums only. Unlike traditional information literacy practices, which are characterized by an individual's search for information, information literacy practices pertaining to online affinity spaces require networks and peer learning in order to become a valued member in the community. The more a person participates as a contributor, and in many cases an editor, the more social capital they have with the community.

## The Task: Assessing the Wiki Texts

Some of the more dedicated contributors to games-based wikis commit dozens of work hours each week to their efforts, and many hope to leverage the skills and experience they gain through this work to acquire jobs as professionals in industry jobs. While previous steps of our research, including case study interviews with active contributors in these communities, have shed light on the motivations and imagined trajectories of these individuals, interviews give little information about the wiki texts themselves. If committed wiki editors want to take the skills and experience they gain in interest-based affinity spaces and put those to work as professionals in industry, we need to know whether their work is of sufficient quality. To answer this question, we turned to the wikis around two popular single-player role-playing game franchises: Bioware's *Mass Effect* series and Bethesda's *Elder Scrolls* series.

To determine the quality of the wiki texts, we conducted lexical and Coh-Metrix analyses of randomly selected pages on each of these wikis. The lexical analyses include measures from several lexical analysis tools, giving feedback about the text complexity for both wikis. For the *Mass Effect* wiki, we also utilized the Coh-Metrix Text Easability Assessor (TEA), which provides information beyond the grade-level or reading difficulty measures, instead giving feedback about the abstractness or concreteness of the words in the text, the simplicity or complexity of syntactic structures, a gauge of the narrativity of the text, and measures of the deep and referential cohesion.

## Lexical Analysis

The lexical and Coh-Metrix analyses of the wiki texts are meant to help us determine that. We analyzed wiki texts using several lexical analysis tools, including the Lexile Analyzer, Flesch Reading Ease, Flesch-Kincaid, and Gunning fog index. Table 1 shows the average results of these lexical analysis tools broken down by wiki and total.

	Lexile Analyzer	Gunning fog index	Flesch Reading Ease	Flesch-Kincaid
<i>Skyrim</i>	1070L	10.70	68.1	7.8
<i>Mass Effect 2</i>	1260L	12.49	53.1	10.1
Total	1180L	11.59	60.6	9.0

**Table 1: Lexical Analysis results.**

The overall Lexile measure for the text places the reading level between eleventh and twelfth grade (based on United States school grade level), which is higher than that of many popular magazines and newspapers published in the US.

Coh-Metrix Data	Narrativity	Syntactic Simplicity	Word Concreteness	Referential Cohesion	Deep Cohesion	Flesch-Kincaid Grade Level
<i>Mass Effect Wiki</i>	35	58	50	32	59	9.5
<i>Mass Effect Official Guide</i>	29	60	53	13	55	8.8

**Table 2: Coh-Metrix results.**

### Text Easeability Assessor (TEA) Analysis

Overall, a comparison of the textual features of the user-created wiki texts and the professionally produced official guide text reveals that these texts are very similar. This similarity suggests that the wiki community produces texts that are similar in style, tone, and reading difficulty, indicating that the interest-driven community—which is organized largely by the more active contributors in such spaces—is able to produce professional quality information resources around the game.

### Conclusions

The lexical analysis shows the high level of intellectual work that is done within the wikis, similar finding have been found by Steinkuehler (2011) using the *World of Warcraft* wiki. Coh-Metrix analyses reveal that the features of the texts across the user-created wiki and professionally produced guide for *Mass Effect* are remarkably similar. What is so critical about these spaces is that the participants find them out of an authentic interest in the content area and contribute voluntarily. Since we live in a world where learning is often confused as being inextricably tied up in school, as academics, particularly those who work in areas related to learning and education, we need to pay attention to places where people find the means to learn voluntarily and work collaboratively to create something they care deeply about. Opportunities for these individuals to leverage their work in interest-based spaces toward their professional career trajectories are worthy of further consideration by leaders in both industry and education.

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# Moving From Content to Discovery: STEM for Younger Learners

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**Abstract:** This poster addresses the question “What are the implications for STEM-focused games and interactive media spaces when pedagogical foci shift from content-based to discovery-based approaches?” The intended audience is broad, from educator to researcher to developer. Information presented includes not only content from literature and industry reviews, but also from field professionals following their own professional applications of STEM in the development and implementation of learning environments. The target outcome is to address current challenges and opportunities prompted by shifting STEM pedagogies from content-driven to discovery-driven learning environments. In embracing these pedagogical shifts, the development and application of game and interactive media spaces serve to provide young learners with deeper foundations on which to build long-term STEM literacy and achievement.

## Games as a Vehicle for Shifting Approaches to STEM Learning

At its core, Science, Technology, Engineering, and Math (STEM) pedagogy is about fostering curiosity and discovery. It is about instilling in children the desire to find out on their own, not always to be taught (Fisher, Bryant, Akerman, & Fischer, 2010). While discovery is a natural inclination of children, it has not been a fundamental goal of today's traditional science and math pedagogy. While standards-based educational frameworks are changing to include practices of science and engineering and crosscutting concepts (NRC, 2011), traditional pedagogical structures focus much more on disciplinary content. Ideally, STEM is about encouraging exploration of the environment, asking questions, and being curious beyond initial comprehension. Doing so fosters the *mindset* of STEM rather than the facts of STEM. This poster argues that games are a key medium in which to support children's development of a STEM mindset.

Sometimes fostering a STEM mindset is as simple as giving a child the space to wonder, and the tools and encouragement to try out ideas. Games and interactive media spaces can be powerful environments for such wondering and experimentation to playfully take place. They are ripe with opportunities for meaning-making. Play that takes place within game spaces requires high level of textual understandings. Game worlds require players to make sense of signs, moving back and forth between interactions with known and unknown information. Players gain understanding by interacting within the world, and by making interpretations that shift and change based on the way the players use signs and symbols in different ways (Salen and Zimmerman, 2004). What play through various media allows is the possibility for children to create patterns of knowing and understanding based on experimentation, discovery, and role negotiations. Mediated play, therefore, becomes a tool with great promise for STEM supportive environments for younger learners.

## A Poster to Identify Implications for Development, Implementation, and Research

With so many products proliferating the market, particularly those claiming to have educational merit, how can developers, educators, and researchers evaluate existing products to identify critical elements of STEM play? Beyond this, how can researchers and developers understand media needs, trends, and opportunities in order to further develop STEM supportive products and platforms? This poster will identify issues regarding the development, implementation, and research of games and other interactive media platforms for supporting STEM learning for young audiences, particularly preschool and early elementary ages.

## Statement Samples for Inclusion From Industry Professionals

**Carla Engelbrecht Fisher**

**Founder, No Crusts Interactive**

Games are a perfect opportunity to grow this mindset as well as help reeducate adults about STEM learning experiences. Intergenerational play, including cooperative simultaneous play as well as pass-back-and-forth interactions, are increasingly supported by the various gaming technologies. Game designers and researchers should leverage these trends to explore the STEM educational

opportunities for both children and adults, particularly through games that foster cooperation, trial and error, and holistic systems thinking.

**David E. Kanter**  
**Director, SciPlay**

In my early work, I explored the impact of project-based science curricula in formal classroom settings. Such curricula were designed to support students working on real-world projects. My findings were interesting in that I could show that these kinds of curricula brought about improvements in students' meaningful understanding, but students' affect did not improve in parallel as initially anticipated. While I believe such curricula are a good approach for developing meaningful understanding across disciplines, I have become concerned about their negative impact on affect due to the significant mental effort they require, resulting in a situation that is at odds with ideal classroom practices and thus negatively experienced by students. Taking a different tack, I have recently begun to explore the potential of guided play games to improve both affect and learning. I believe that play in an informal setting can be carefully guided as a game-with-rules that integrates science content in a compelling and intrinsic manner. Also, such play may serve as an important bridge from the informal to the formal setting to promote deeper understanding while also building students' positive affect toward science.

**Scot Osterweil**

**Creative Director, MIT Education Arcade**

While harnessing the natural curiosity of children in the service of exploration is a necessary first condition of STEM education, it is not in itself sufficient. As children explore the world, their curiosity leads them into observation and sometimes hypothesis formation, but it can also lead them to misconceptions and even magic thinking. Properly taught, STEM education helps students understand that the formation of knowledge comes through systematic modeling, testing and iterating as well as exploring. Traditional education kills the exploration by emphasizing the memorization of facts, but it also fails at promoting systems thinking by reducing it to a "scientific method" that flattens the experience for students, and drains the sense of wonder from what should be inspiring engagement with real phenomena. Happily, though this form of systems thinking does not come easily, it does emerge in the ways children engage with the models and simulations that animate most electronic games. Through game-play children do learn to reason about cause and effect, test hypotheses, and control for variables. The challenge of designing opportunities for reflection into the game ecology is second in difficulty only to the challenge of designing a genuinely engaging game, but it is a challenge well worth the effort.

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# Emulation as archive and archival practice

Chris Russell

**Abstract:** With some alarm, Henry Lowood *et al* describe the looming issue of digital game preservation—posing the question, "What if we do nothing," they argue *de facto* that we are, in fact, doing nothing. I argue that digital gaming industry and culture is organized around a logic of supersession; in the words of James Newman, "the next game is the best game." In this milieu, the practice of game emulation reclaims and relocates the gaming archive. Emulation is legally ambiguous and contingent on evading corporate notice; games are distributed freely through back channels. Emulated games bear the trace of their pirated nature - as a preservation and reproductive strategy, emulation creates an archive that is both fugitive and ephemeral. In the pseudo-anonymous bittorrent swarm and the ROM site threatened with takedown, the work of digital preservation is conducted without sanction, constantly shifting and endangered.

The archive is always already in peril. Unless we act now, it will be lost. So the authors of "Before It's Too Late" tell us—the problem of game preservation is staring us in the face while "the games you are making will disappear, probably in the next few decades." (Lowood et al., 2009) Strikingly, the authors of the paper mention very little of the enormous community of developers creating ad-hoc emulators to preserve older games, and completely disregard the bootleg trading and distribution of games that has been going on for years. Perhaps this is because they're self-consciously addressing game developers, who likely view emulation as a profit-stealing threat. Perhaps this is because they're concerned with saving the marginalia of games—their manuals, design documents and so on. Regardless, extant emulation practice is rendered invisible. In this paper, I offer a preliminary discussion of the online, borderline illegal practice, development, and distribution of emulators and games—henceforth abbreviated as the "emuscene." I approach this first through making a large claim, arguing that the crisis foretold by Lowood, *et al* is real, embodied by a games industry organized around an infatuation with newness and nextness. Through this, the emulation underbelly is supported even as it is decried, and works as an archive and an archival practice at the borders of legitimacy.

Unlike other entertainment media, such as film, the distribution of games is remarkably single-tiered. Whereas we're used to the progression of movies being played in theaters, moving to on demand, then to DVD and so on, games are released and move directly to the second-hand market. Once production has stopped, the number of copies in circulation is rarely increased. While you might think this would result in high prices, you'd be wrong. Used games depreciate rapidly—if you walk into your local games retailer, buy a copy of the last AAA release at \$60, walk right in and sell it back, you'd be lucky to get \$15 for your trouble. The high profit margins on the repurchase of "old" games entering the secondary market—somewhere around 40%—drives the business model of GameStops, Electronic Boutiques, and other video game specialty stores. More recently, bigger box retailers such as WalMart and BestBuy have entered the arena because of the attractive profits. The working definition of "old" in this case probably extends back 5-6 years—any farther back, and Ebay is likely your best bet.

The creation and consumption of the product of emulation offers an example of what Eugene Levy (1984) has called the "hacker's ethic," an ideological stance organizing the practice of technological enthusiasts at the fringe. For Levy, hackers approach technology with a ludic attitude, seeking to decode and recover data and processes hidden by the mechanisms of copy protection, to lay bare what Gittelman (2006) identifies as the unknowable functioning of the computational digital device. The hacker's ethic involves free distribution, open source coding practices, and most tellingly, the pseudo-anonymized mobility of an un-policed Internet. Mizrach (1997) defines the term succinctly: "the basis of the Hacker Ethic, then and now, has been a rhetoric of opposition to the idea of intellectual property and the conservative worldview of corporate computing practices." (p. 138)

The emulator, first and foremost, exists as programmed by a developer, in a certain programming language, to interpret another programming language—that of the game. The emulator ostensibly is a container format, a method to play back other texts. The emulator itself, however, is a historical document designed at a specific time for a specific use. Consider two competing SNES (Super

Nintendo) emulators, bsnes and ZSNES. The former, designed to exactly emulate every behavior of the original console down to the level of code, requires enormous computing power to simply run. The latter, by comparison, uses a number of workarounds to make the emulator workable on almost any hardware setup. ZSNES is intended to be used to play games now, without significant concern for accuracy. Bsnes, by contrast, is a museum emulator—to make the games function as closely as possible to their original use. Both emulators, however, will eventually become outdated as their programming languages become stop being supported; they themselves will require an emulator to run. The emulator, as archival practice, is somehow always *ephemeral*.

The act of emulation bears the trace of the emulator. Like Gittelman's example of the first appearance of the word "internet" in ProQuest's database due to a transcription error, so emulation bears the marks of that which emulates. Some of these traces can, in Byuu's (2011) words, be "maddening"—the music in the title of *Legend of Zelda: Link to the Past* (Nintendo, 1991) running slightly out of sync with the animation—but they mark the game's transition from one platform to another. The invisible text of the emulator, usually hidden from all but the most tenacious, becomes writ large upon the text it reproduces.

Finally, the emulated are the collections of ROM images exchanged, hidden and migrated. The collections of ROMs scattered throughout the web constantly shift and change; their dubious legality making them always subject to potential disappearance. BitTorrent swarms for torrents containing entire catalogs for consoles may be active today, but tomorrow it may be empty, only hinting at its contents. Nevertheless, the discourse of emulation is convinced of its own tenacity—there's a feeling that no matter how many ROM sites are shut down, no matter how many swarms dwindle down, the games will still be "out there," somewhere in the technological imaginary. The ROM archive is always *fugitive*.

The notion of emulation as an archival practice, as seen through the active gaming practice, is simple on the surface but profoundly fraught beneath. The interaction of the illegality of emulating with the tacit approval of a relatively unconcerned gaming industry has created a free floating archive, hidden except to those with insider knowledge, curated by the shifting BitTorrent swarm, the ephemeral ROM site, and the development of emulation at the margins.

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# Gaming the System: Reforming communication and legal literacy through gameplay

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**Abstract:** *Gaming the System* is a practice-based exploration into how the pro bono legal community can use games to bridge the justice gap faced by undocumented detained immigrant youth and to increase their engagement in the pursuit of justice. Of the 10,000+ children detained within the U.S. each year, many are eligible for legal relief but are not guaranteed legal counsel. Immigration law is one of the most complex legal codes in the U.S., and it's unjust that a child should have to navigate this labyrinth by himself without legal guidance. Games can make complex legal information accessible to a child so he can make more informed decisions and ask questions specific to his case. In *Make a Move*, a game that teaches youth about the release from detention process, the mechanics provide tacit lessons detained youth do not always learn and yet should apply in real life.

**Keywords:** serious games, citizen engagement, participatory learning, legal literacy.

## Introduction

*Gaming the System* is a practice-based exploration into how the pro bono legal community can use games to bridge the justice gap faced by undocumented detained immigrant youth and to increase their engagement in the pursuit of justice. Although the U.S. government believes these children lack lawful immigration status and has initiated proceedings to remove each child from the U.S., many are eligible to successfully defend themselves against deportation and receive legal permanent residence. However, a child needs a lawyer in order to know that they qualify to stay in the U.S. and to access the legal relief for which they qualify. More than 10,000 children are detained within the U.S. each year, but none are guaranteed legal representation. Immigration law is one of the most complex legal codes in the U.S., and it's unjust that a child should have to navigate this labyrinth by him or herself without any legal guidance. Playing content-specific games, particularly in the absence of legal advisement, can help immigrant youth understand their legal situation and actionable choices.

This installment of *Gaming the System* focuses on the design of a board game that teaches detained youth over the age of 12 about the release from detention process. A child who has just arrived at a detention facility feels alone, scared, and imprisoned. His first concern is about how to get out of the facility and then how he can stay in the U.S. In *Make a Move*, players take on the role of a detained immigrant child whose objective is to be approved and released from the detention center. In order to achieve this, players must meet with the case manager (a non-player character), choose a release option, and then traverse the board and land on designated spaces to collect the 3 key items required for that form of release. In the game, as in real life, the three release option choices are:

1. *Reunification* – choosing to be released into the care of family or a friend living in the U.S.
2. *Federal foster care* – requesting that the U.S. government find you a suitable foster home
3. *Voluntary departure* – returning to your home country without re-entry restrictions

## Methodology

I am a game designer collaborating with Shalyn Fluharty, an immigration attorney, on the design, implementation, and assessment of this and future games for immigrant youth. We have tested our first game extensively with immigration attorneys, immigrant youth organizations, government immigration employees, juvenile facility staff, and children currently or recently detained. We will soon start assessing the knowledge acquired from the game with detained children at the Dobbs Ferry, New York facility. *Make a Move* and future games will be accessible online at AmigoLegal.org, a non-profit organization that creates and distributes Know Your Rights resources to immigrant children.

## Design Process and Testing

The motivation for creating these games is to make complex legal information accessible to children and to address the huge justice gap faced by detained immigrant youth. Currently, all the information detained immigrant youth receive is from an authorized official if and when one is available. However,

a game can teach these youth the essentials of the release process and reserve lawyers' and facility staff's limited time for more complex questions and needs. After playing *Make a Move* a case manager commented, "When we explain, for example federal foster care, the kids have a lot of questions, they don't understand. We have to meet with them 1, 2, 3 times and explain. So if they play this game they'll get a lot of that information." By actively engaging with the information in a game, the players have a better chance of retaining the information than by just hearing it in a conversation.

The game mechanics provide tacit lessons detained youth do not always learn and yet should apply in real life—that he can choose how he is released, that concurrent planning is advantageous, and that being involved in his case and following up with his case manager, potential sponsor, or lawyer will help move the process along. In fact, in the game a player must first meet with the case manager (landing on the game space currently occupied by the case manager) before any progress can be made. At this first meeting a player finds out the details for the 3 release options by flipping over the envelopes in his submission packet. He must read over these options and choose which one to pursue by placing a cube on his selection. He can now take turns moving around the game board and try to collect requisite items for any of the 3 release options. This option to select one but pursue all 3 options represents a concurrent planning strategy that in reality is not employed enough. A player can also choose to change his selection whenever he meets with the case manager in the game, another fact unknown to most detained youth. Once a player has collected all 3 items for his selected option, he must seek approval for release from the authorities. In reality this is not automatic—there is circumstantial chance involved. The game thus requires a player to roll a high enough number on a die for a chance at approval. Then, approval and release from the facility is contingent upon the player reciting from memory the 3 items he collected for his selected release option. This game rule ensures that players are not just collecting but also remembering these requirements.

In testing the game we realized a stark difference between the reactions of never-detained immigrant youth and detained youth to the narrative game content. *Make a Move* has chance cards that give a flavor of events that could progress or set back your case. For example, there are consequences if you get into a fight with a child or staff member while in detention. The never-detained youth found this depressing and felt discouraged while playing. Worried about upsetting the detained youth, we removed the chance cards from their playtest, but then they inquired as to why such negative events were not part of the game. We then tested the chance cards with them, and while the setbacks upset them, the detained youth agreed that this version of the game felt like their reality. Based on this feedback we now provide two ways to play *Make a Move*—with or without the chance cards.

## Conclusion

We discovered multiple uses for this game by testing with the immigration community at-large. Firstly, facility staff members see the game as especially useful for children when they first enter the facility since they are completely unfamiliar with the release process. Furthermore, facility directors want to use the game as a training tool for new staff. We also discovered that children who have been detained for many months still enjoy playing the game because they find it fun, and if they play with children who have recently arrived to the facility, they can share their experience and acquired knowledge with them. In this way the game provides a unique opportunity for children who are living together to interact with each other, something that currently does not naturally occur. Finally, teachers at schools with a large immigrant student body can play the game so that undocumented youth at risk of detainment are informed in the unfortunate case they are detained.

*Gaming the System* is introducing to the pro bono legal community the use of games as a new effective model for teaching youth (and people in general) their legal rights. However, it is important to acknowledge the challenges of representing real legal information and processes in a game. Interpretation is central to understanding the full extent of legal code and is based on the nuances of a case. Serious games can serve as excellent simulations of reality, but typically liberties are taken in order to focus the gameplay on a core message or evoking a specific type of emotion from players. In designing a legal game that actually serves as an applied learning tool we learned through many design iterations that the game mechanics should represent the fundamentals and not the nuances. It was easy to get caught up in the minutia, a place in which legal experts thrive, but this ultimately added too much complexity for a game that children could play with little to no facilitation. As we continue to create legal games for immigrant youth we hope that other legal practices will also catch on to the benefits of using games to communicate complex and systemic legal content.



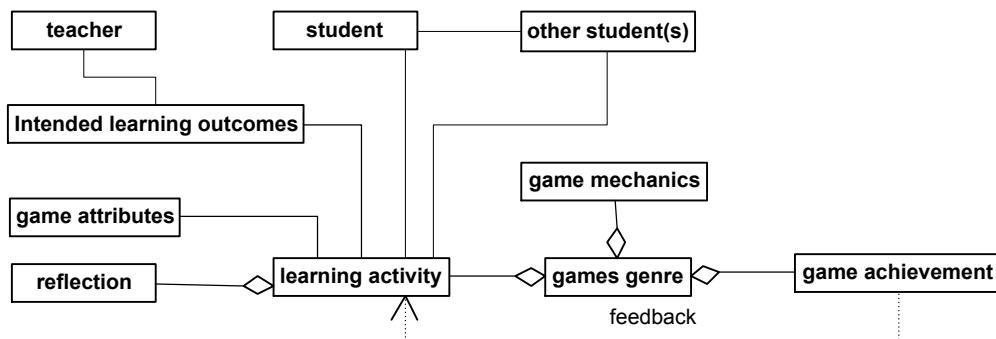
# A Conceptual Teacher-Learner Model for a Collaborative Learning with Serious Games

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**Abstract:** This paper introduces a conceptual Teacher-Learner framework for a collaborative learning with serious games. An initial study identified twelve attributes of educational serious games that can be used to support effective learning. These attributes are used in the conceptual framework to support learning and pedagogy in combination with a game. A considerable number of serious games have been developed over the last ten years, with varying degrees of success. Due to a lack of clear standards and guidelines for game developers; it is difficult to justify claims that a specific game meets the learner's requirements and/or expectations. This paper defines a conceptual model for serious games that will contribute to their design and the measurement of achievement in meeting the learners' requirements.

## A Conceptual model for collaborative learning

The framework is an evolution of the input-process-outcome game model discussed by Garris et al (Garris, Ahlers, & Driskell, 2002), the conservation framework by Laurillard (Laurillard, 2009) and the conceptual framework presented by Yusoff et al (Yusoff, Crowder, & Gilbert, 2010; Yusoff, Crowder, Gilbert, & Wills, 2009). The individual components of the model are discussed in this section.



**Figure 1: Conceptual Framework for Collaborative Learning shown as a Structural Class diagram.**

## Game attributes

Game attributes are those aspects of a game which support learning and engagement. The game attributes are developed based on the critical thinking resulting from the literature review on behaviorist, cognitive, constructivist, educationist, and neuroscience perspectives (Yusoff et al., 2009), as listed in *Table*. The serious games framework presented in this paper identifies the major components that create an effective model for learning through the use of serious games. Every component inside this framework plays a role to ensure that learning would take place while playing the game. We propose this framework as an appropriate basis for effective serious games design for designers and teaching practitioners.

Attributes for Serious Games	Values for Learning and Education
Incremental learning	Learning material is delivered incrementally. Additional new knowledge is delivered and not done all at once. It will have a proper start and end section. Learner feels and learns in a natural way and less complex.

Linearity	Learning will be in sequence. This will suit the sequential learner. However, due to the game's flexibility, active learner can skip chapters.
Attention span	This concerns with the cognitive processing and short-term memory loads placed upon the learner by the game. These loads need to be carefully calibrated to the target learner. Not to be overwhelmed and too long in the learning process.
Scaffolding	Support and help during learning within the games.
Transfer of learnt skills	Learnt knowledge to apply to other skills in the next level.
Interaction	Higher engagement, higher learning.
Learner control	Active learning, self study and self exploration based on individual pace and experience.
Practice and drill	Repeating for harder task, better knowledge retention and can have plenty of game activities for drills.
Intermittent feedback	Learner to reflect on what has been achieved so far and motivated for higher score (higher learning). Also using just in time feedback for learning.
Reward	Encourage learner and keep motivated. Negative reward as punishment within the game may also contribute to learning.
Situated and authentic learning	Learning where the learner can relate what is being learnt within the game to the outside world.
Accommodating the learner's styles	To suit and to reach out to different learner styles.

**Table 1: Serious Games Attributes**

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# **Art Exhibition**



## **Pen and Sword: Character and Narrative in Games and Art**

### **Curatorial Statement**

This is a multifaceted pastiche of discrete traditional, digital, interactive, collaborative, and hybridized works from a group of professional disciplines which share common tools but different goals. On the surface it is a mix of works from the games industry paired with the work of more traditional artists. The tools shared by these disciplines are obvious as art practice and art education grow over time to include the *ars technica* of industries and design fields like graphic design and game design. This relationship of shared technology, as a means, is apparent but there are other tools which are shared that reach deeper toward the roots of our culture. Games and especially interactive video games now use some of the tools traditionally reserved for art and literature, namely narrative tools, as commonplace elements. As a result, video games, for better or worse, sit alongside the traditional means of cultural dissemination, literature, art, history, and religion, as an equal. It is the adaptation and use of storytelling, characters, lush environments, and deep narratives which draw many players into gaming by the same aesthetic attractions that draw readers into books and art lovers into museums and galleries. And as any great art form expands and colonizes space conflict follows (they rioted in the streets, after all, following the premier of Stravinsky's *The Rite of Spring*) this is reflected in the development and consumption of video games. The push and pull, as we war over our cultural narratives and identity, is echoed throughout the exhibit in the content and character of the works.

-Arnold Martin, *curator*

## Cherubic Intervention

Heather Accurso | Independent Artist | [www.heather-accurso.de](http://www.heather-accurso.de) | specimyn@harss-accurso.de

### Statement

Heather Accurso's most recent drawing series, *Cherubic Intervention*, combines fantasy with reality. Contemporary cherubic angels sprouting botanical projections protect humans and nature from today's threats--poised to fight war, terrorism, natural disasters and the exploitation of the earth's resources. Whether the Putti are successful, or not, is unclear...for the act of saving is not depicted in resolution.

Accurso began the series while residing in Cologne, Germany (from 2003 to 2008). Living in a foreign country, still physically and psychologically affected by World War II's devastation and overwhelmingly opposed to the Bush administration's policies, fueled her decision to make political work. Also significant—fellow immigrant students in her intensive German classes had fled oppressive situations. Important artistic influences in Cologne were Stephan Lochner's luminescent cherubs and Ernst Barlach's *Floating Angel*.



# Assembling to Kill Ragnaros

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## Statement

This series of illustrations shows the progression of the cover art for *Leet Noobs: The Life and Death of an Expert Player Group in World of Warcraft*.

The title comes from Chapter 3 of the book, which describes the work that went into killing the last boss, Ragnaros the Firelord, in Molten Core, a fiery cave system in *World of Warcraft*. A player group is composed of both humans and nonhumans, and the virtual space of the game was always mediated through a network of technological objects. I tried to get at this by showing my orc rogue, Thoguh, playing through the interface of the desktop computer, which includes the various add-ons that I used while playing.

I first did the ink outlines with an iPad 2 and a stylus, using screengrabs from a *World of Warcraft* model viewer as reference. Each figure was saved and imported into Photoshop as a separate layer where I could then move them around until I was happy with the composition. A color layer was added under each figure and painted using a Wacom tablet in Photoshop. This art was my first attempt to draw and color completely digitally, where before I would scan in pencil-and-paper line art to then color digitally.

## Bio

Mark Chen is a postdoc at the University of Washington looking at player learning with science and math games such as *Foldit* and *Refracton* and helping the nonprofit organization Educurious by integrating games and gameplay into the redesign of high school biology and language arts. He has a new book on learning in online games titled *Leet Noobs: The Life and Death of an Expert Player Group in World of Warcraft* for which he claims the best part is the cover art. Prior to doctoral work, Mark was the webmaster and a web game developer for the Oregon Museum of Science and Industry, and he holds a BA in Studio Art from Reed College. You can read more about Mark (and perhaps commission illustrations for academic titles ;)) through his blog at <http://markdangerchen.net>



## Charming Butcher

Andrea Coates | Independent Artist | [www.andreacoates.com](http://www.andreacoates.com) | [andreacoates@gmail.com](mailto:andreacoates@gmail.com)

### Statement

If memory only lives in our mind, history is a collectively shared memory. It becomes close to fiction, however, thanks to the human perception. Our understanding of history is not always factual and is sometimes fabricated for the storyteller's liking, or their want of controlling the truth.

I am interested in the unglorified parts of history- the characters that are unflatteringly human. They carry their traits and flaws with them through time, and hardly change, even though their stage may differ. Their place is constructed around them, like two-dimensional theatre props with no ground to establish a forward or a backward.

These characters are desperate, whether it is for survival, power or ego. And, much like a storyteller in control of her portrayed truth, by drawing these characters I myself control their desperation. Perhaps I am attempting to understand what unites all us humans, and also how to forgive offenses. For the bad found in one human is a human trait after all.



## Images of Magic and Space

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### Biography

Liz Danforth is a figure of note in the games industry, best known for her illustrations. Since 1978, she has worked as an artist, writer, editor, and game developer on tabletop role-playing games, card games, and board games. In addition, she has worked as a writer and scenario designer for computer and video games. Her credits include work for Dungeons & Dragons, Magic the Gathering, and for licensed Star Trek and Middle Earth game projects. She has created maps and illustrations which appear in both mainstream novels, and fantasy novels and anthologies. She was inducted into the Academy of Gaming Arts and Design's Hall of Fame (1995).

She is presently at work on scenario designs for Wasteland 2, which just received nearly \$3M in funding via Kickstarter (having been one of the original team to create the first Wasteland computer game, released in 1988). She continues to freelance art, writing, and design from her home in Tucson, Arizona. Her website is [www.lizdanforth.com](http://www.lizdanforth.com) and she tweets from @LizDanforth.

- June 2012



# One and Five

Josh Fishburn | University of Wisconsin – Whitewater | joshiselectric.com | josh.fishburn@gmail.com

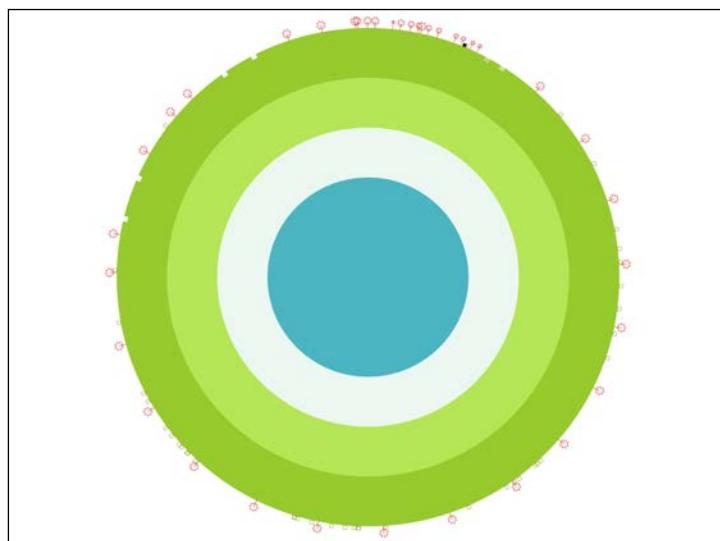
## Statement

One and Five is a collection of networked videogames that share a similar theme. I'm interested in the possibilities of networked communication between games, but this piece takes it one step further and features a set of games (or game-like software) that share some visual elements but vary the meaning of those elements across the collection.

The games were initially based on ideas of separation and anxiety. They quickly became more about how the abstract objects and game mechanics interacted, both within each game and across the network. I'm especially interested in exploring the idea of an abstract world with several different perspectives and points of entry, and I hope the network functions poetically to achieve this.

## Biography

Josh Fishburn teaches game design, programming, and web development in the Media Arts and Game Development program at the University of Wisconsin-Whitewater. He creates experimental games and game-based work, is interested in how networks function in games, and is excited that modern games are exploring this further. Prior to coming to Wisconsin, he was a researcher and media-artist-in-training at the University of Denver and had a past life as a programmer at Motorola.



## 12 Sided Pirate

Amanda Marie Gatton | MIAD | [artist-portfolio.net/AmandaGatton-Art](http://artist-portfolio.net/AmandaGatton-Art) | amandagatton@miad.edu

### Statement

As an artist I explore concepts of social behavior, customs and beliefs. I use performance to study the actions of the public in present day culture. *12 Sided Pirate* is a five-hour performance in which I assumed the role of my pirate character, Captain Rose, and interacted with the world on a D 12 based system. Decisions were made during this performance by shaking a treasure chest with a 12 sided die inside, each side called for a different action based on the list of rules I put in place for myself. This system is similar to many table top games that require a die roll for every action the character performs. Whenever I came to a place where an action or decision was required my first response was to shake the treasure chest and observe the number on the die. I aim to bring attention to the current social standards. By setting up and following these game styled rules I am experiencing actions that would normally only be imagined.

### Acknowledgments

Board games/ roleplaying  
My Crew



## Big Huggin' an Affection Game

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### Statement

Today the world of game interaction is an impersonal one. It is one where touch is mediated through glass and plastic. Where multi-touch means hands mediated through sleek materials without natural texture. Why isn't touch more personal? Why isn't touch more tactile? Big Huggin' is a game designed for use with a custom teddy bear controller. Players complete the game by providing several well-timed hugs to a 30 inch teddy bear. It is an experiment and gesture in alternative interface. Instead of firing toy guns at countless enemies or revving the engines of countless gas guzzling virtual cars, why not give a hug? A hug is a simple gesture. It is one of the first physical expressions of affections a child learns. It is a gesture for the familial through the romantic. It is a gesture of mutual benefit.

### Biography

Lindsay Grace's creative practice is focused on uses of interactive media to explore cultural standards. Extending the foundations of human computer interaction, play design and design anthropology, the work explores the ignored. This work is computer game, art, sculpture or some interdisciplinary amalgamation. Lindsay's work pursues educational experiences and editorial critique of the social relationship between computers, humans and each other.



## Drive

Carson Grubaugh | Independent Artist | [www.hodtech.net](http://www.hodtech.net) | [clubgrubbug@gmail.com](mailto:clubgrubbug@gmail.com)

### Statement

Narrative and character can be built out of such small moments, passed over details, and quite reflections. This fact about day-to-day life is purposefully ignored in the majority of our narrative mediums for large, loud, exciting moments. We use this overload to escape. A good drive is a quiet escape, a few hours of calm, reflection, and introspection, a time in which personal character is opened up a tiny bit more to the world that it is embedded in.

A game to play: *Take a quarter. Get in your car. Heads = right and tails = left. Flip the coin to determine which direction to exit your driveway. If parallel parked, let heads = continue forwards and tails = turn around. Keep going until you hit an intersection where you must turn either left or right. Flip the coin, follow the direction. Repeat for as long as you would like. If you hit a dead end turn around and at the first cross street flip the coin for left or right, do not head back the way you came any longer than necessary. Should you stop for food or bathroom breaks continue on in the direction you were headed before you stopped. Direction changes should only occur at dead ends and 3 way stops.*

### Biography

Carson Grubaugh earned an MFA at Cranbrook Academy of Art in Painting. He also holds two Bachelor Degrees, one in Fine Art and another in Philosophy, both from the University of California at Berkeley. Carson named the Mercedes Benz Financial Services Emerging Artist of 2011 and has since had his work exhibited in the United States and Germany.



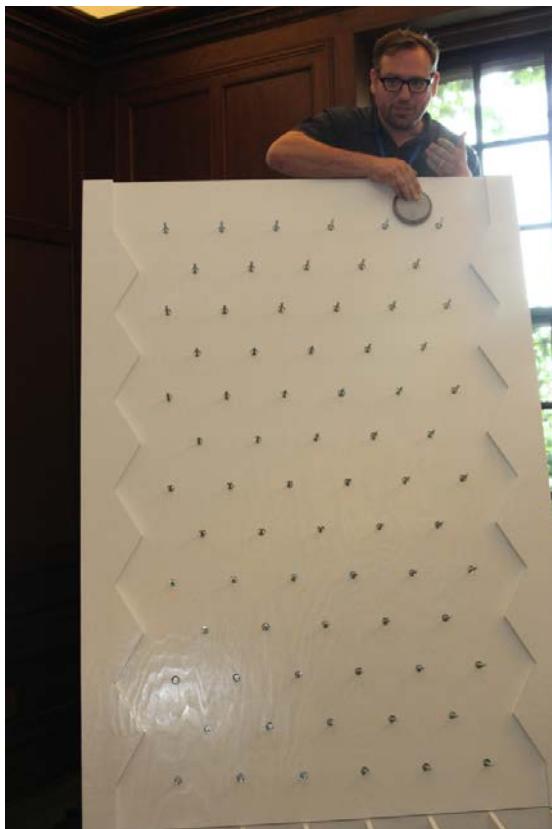
## KitschO

Liz Heller | University of Wisconsin – Madison | |  
T. Scott Collier | Independent Artist | tscottcollier.com

### Statement

KitschO is a handmade ‘Plinko’ board appropriated from the game show ‘The Price is Right’. At the bottom are seven receptacles, five of which contain a fragile figurine instead of a monetary value as on the show. Each participant drops a steel puck down the face of the board for the possibility of smashing a piece of kitsch. If the participant hits a figurine, the broken remnants are swept into a Chinese takeout box, signed by the artist and given to the participant as a giveaway prize. If the puck hits an empty receptacle the participant gets an intact figurine as a giveaway prize. Creating this piece through a fine art lens, kitsch is considered a low art, an overly sentimental mass-produced commodity, thus attractive to smash. The cheap mass-produced carryout container is allusive to the kitsch inside it, which is recontextualized as a new art object through the KitschO game. This signed artifact renders the “low” piece of kitsch into “fine” art. In an increasingly digital world, this game is physical, loud, and manual. It entices participants with the possibility of visceral satisfaction. The notion of winning and losing is individualized by each participant’s personal view on kitsch.

This is Heller and Collier’s first professional collaboration as sculptor and architect. Liz Heller is currently an MFA candidate in Sculpture at the University of Wisconsin at Madison. T. Scott Collier has an M Arch from IIT in Chicago.



## Inhabited Space

Bernd Kreimeier, [bernd.kreimeier@oneArrow.com](mailto:bernd.kreimeier@oneArrow.com)  
Chris Laurel, chris@cosmographia.info

"Inhabited Space" is an exploration of interactivity based on the notion that, while ultimately incomprehensible to the human mind, our solar system is the only measure of space and time on a cosmic scale that is available to us. We propose visualizations that, interactively or as recording, attempt to use the "familiar" space of Earth, Moon and Sun to help the recipient experience not only the scale of the space we live in, but also our already-occurring impact on it. In particular, this means the use of "space debris" past and present, as well as fictional "future" debris, as part of a narrative of how the Solar System is slowly becoming an "inhabited space".

"Inhabited Space" approaches the connection between space, time and narrative from a different perspective. Scale and dimension are a fundamental test case for the inquiry into the capabilities of interactive experiences to expand our comprehension of the universe we live in. We see the importance of an interactive experience as one of low latency, i.e. immediacy of response in addition to vivid imagery. Our interest is in crafting software tools and experiences that allow us to virtually explore frontiers currently inaccessible to human beings.

In this exhibit we attempt to use the familiar—yet incomprehensible—dimensions of Earth itself to measure Near-Earth Orbit and cis-lunar space, and outwards from there, the Solar System. We are attempting to demonstrate our tentative steps of exploration by means of tracking its debris. Through the past and present evolution of "space debris" we are attempting to capture both the timescales and the distances involved. By means of fictional "future debris" we seek to illuminate the likely traffic lanes and rest stops in near-Earth space, in a procedural narrative of possible centuries of coming exploration.

The visualization builds upon existing particle system facilities in "Cosmographia", a new simulation tool, and uses the VESTA graphics library from Astos Solutions. See <http://www.cosmographia.info/>.

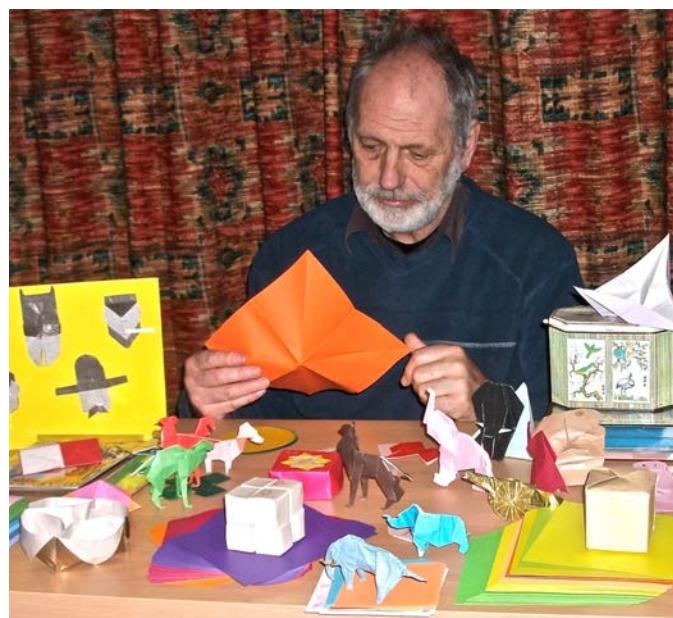
## Cranes for Peace

Philip D. Noble | Independent Author | [www.bubblestrings.net](http://www.bubblestrings.net) | philipdnoble@btopenworld.com

### Statement

Philip D. Noble is a Scottish author and visual storyteller. Philip has degrees in Science and Divinity, and a Doctorate in Post Modern Studies and is an ordained Christian minister. He discovered early on the value of using simple visual aids such as string loops, paper squares and soap bubbles to enhance his story telling. Philip has led workshops in the U.K. and contributed to the International Council of Children's Play in Zurich, Paris and Lisbon and has been a regular performer and workshop leader and exhibitor at the European Christian Artists seminar and at Festival David events in Spain.

His more recent work includes working with Audi cars to produce the prize winning commercial 'Audi Strings' in 2009 and with Caravan Productions in Belgium to help create a new dance piece using giant string shapes, premiered in Brussels in May 2012.



## The Infected!

Brian Pelletier | ERIA University of Wisconsin – Madison | bpelletier@morgridgeinstitute.org

### Statement

The Infected was created as pre-visualization art to define the narrative artistic style for a Stem Cell game about an infectious outbreak turning the infected into zombie like beings. During pre-production we explored the ideas for a comic book style. When creating the conceptual art I was inspired by pulp fiction comics but also wanted to maintain a modern look. The ink style and half tone dots achieved the look for an old pulp image where the color blending with smooth gradients and texture offer the modern approach to comic coloring.

### Acknowledgments

Special thanks to the Artists at ERIA Interactive who gave valuable feedback during the creation of the conceptual art in defining the artistic style to be used for the narrative portion of the game.



## Bullet Hell

A. J. Patrick Liszkiewicz and Anton Hand | Independent Artists | [rustltd.com](http://rustltd.com)

### Statement

**Bullet Hell** (2012) is a side-scrolling platform game, designed for installation, in which the user controls the movement of a bullet. As with games like *Canabalt* and *Robot Unicorn Attack*, the object of the game is to prolong gameplay by avoiding collisions with the surrounding environment, and as gameplay progresses the game stage moves faster and faster until the user inevitably “fails” or “dies”. The game is driven by a core loop that revolves around a central decision point: should the user intervene and move the bullet? If the bullet is not moved, it will strike its target and then the game will rewind to the beginning and automatically begin again. This means that, in a gallery setting, the game will loop indefinitely in the absence of user interaction, allowing spectators to approach the work as they would an animation or video installation. Thus, *Bullet Hell* explores the artistic potential of a popular game genre by removing its familiar feedback mechanisms—such as score, lives, music, and interface—and foregrounding its eternal recurrence and limited control-set within the context of a gallery-based exhibition.

### Biography

A. J. Patrick Liszkiewicz and Anton Hand are members of RUST, LTD. (<http://rustltd.com>) a collective of media artists from Buffalo, NY. In the past, their collaborative work has been featured in the Carroll Gallery at Tulane University, the Ellen Powell Tiberino Museum in Philadelphia, PA, the Humanities Gaming Institute at the University of South Carolina, the Post\_Moot Convocation at Miami University of Ohio, and Play/Share: Beyond/In Western New York. More recently, their game *The Hold* (<http://theholdgame.com>) won the “Best in Show” audience award at Game Fest 2012, and has been exhibited at TEDxUSC and the 2012 UCLA Game Art Festival.



## Helm of the Yellow Admiral

Chris Hindle | Independent Artist | chris@driftstudio.com

### Statement

The phrase yellow admiral is drawn from the history of the British Royal Navy and it refers to a post captain that has been promoted to admiral, but has not received command of a squadron or fleet. It was a promotion used to clear captains off the list to make way for new and more promising officers to move up the ranks. In short, the captain is given a back handed compliment while being forced to retire. This piece references, not so much the imbued disgrace, but the let down of a life's worth of experience that is left to languish on shore.



# DIHOWITZERCERATOPS

Arnold Martin | GLS Artist in Residence | arnoldmartin.com | arnie.martin@gmail.com

## Statement

DIHOWITZERCERATOPS (2012) is a continuation in a series of work that began in 2010. Abstract simplified outlines from photographs and drawings of objects from prehistory to the present day are combined in planar relationships to create fantastical and self-contradictory three-dimensional skeletal constructions which maintain a level of believability when taken as a whole. The sculptures resemble monumental versions of wood model construction kits found in the gift shops of natural history and science museums. The series began with thinking about the process of making sense of the artifacts and physical record of a post human earth (a task for some distant future race of creatures capable and willing to undertake interstellar archeology) and how confusing the human record could be considering our affinity for unearthing and preserving objects from the very distant past. The work has since evolved to more widely consider and explore the implementation of fantasy, or at least imaginative thinking, in the process of sense-making when only limited data are available.

## Biography

Originally from Flint Michigan, Arnold attended college at Wayne State University in Detroit Michigan. Arnold is an artist and designer and most recently earned his MFA in Studio Art from the University of Wisconsin – Madison in the spring of 2011. His work is primarily three-dimensional, sculptural, and physical; though his process is a hybrid of digital technology and old-fashioned shop techniques. Using digital design tools and a variety of materials and processes he works to create fantastical, self-contradictory and yet subtly plausible objects which can be both enigmatic and utterly self-conscious in their construction.

Arnold Martin is the GLS Artist-in-Residence and curates the GLS Art and Games Exhibition.



# Writing Things We Can No Longer Read

Alex Meyer | Bellevue University | alexmyers.info | everyonenot@gmail.com

## Statement

Writing Things We Can No Longer Read is an absurdist artgame about the beauty of apophenia. It is the fourth iteration in a series of ephemeral artgames that address the human need to apply symbolic meaning onto everything we see.

We transcribe meaning constantly and this writing increases until it reaches a critical mass of meaninglessness. Then it keeps going and eventually comes back to the realm of meaning again. I hope.

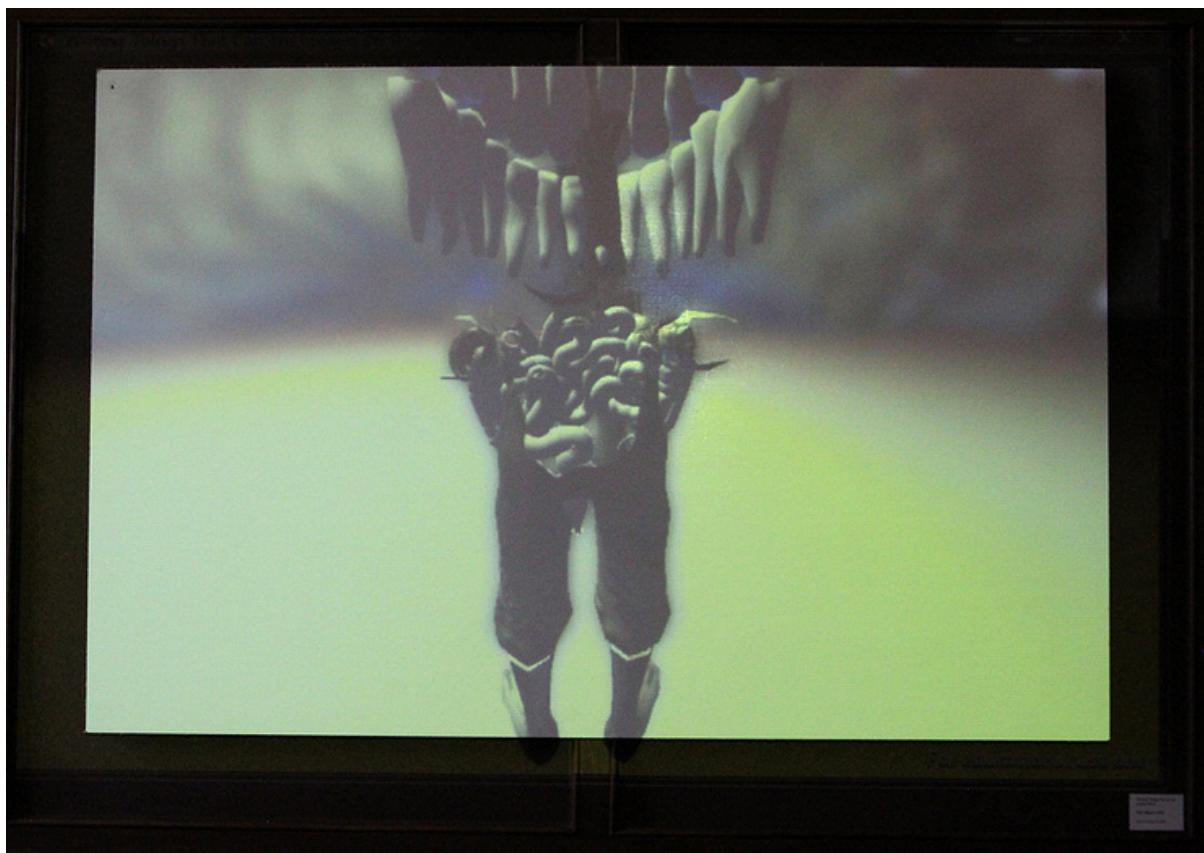
## Biography

Alex Myers is an internationally exhibiting artist and educator interested in pretty much everything. At the moment this means exploring the rough edges of art, interaction and play.

He received his **MFA** (with Honors) in *Interactive Media & Environments* at **The Frank Mohr Institute**, Groningen, The Netherlands in 2009.

In addition to making all sorts of weird stuff, he is an Assistant Professor & Program Director of Game Studies at Bellevue University.

Alex also mentors at the **Kent Bellows Studio and Center for Visual Arts** and gives talks and workshops about Games, Interaction Design and New Media Art.



## Translations

Rachel Cohen | Independent Artist | [www.rachelcohen.co.uk](http://www.rachelcohen.co.uk) | mail@rachelcohen.co.uk

### Statement

There are 2 games behind this work, and a psychology experiment.

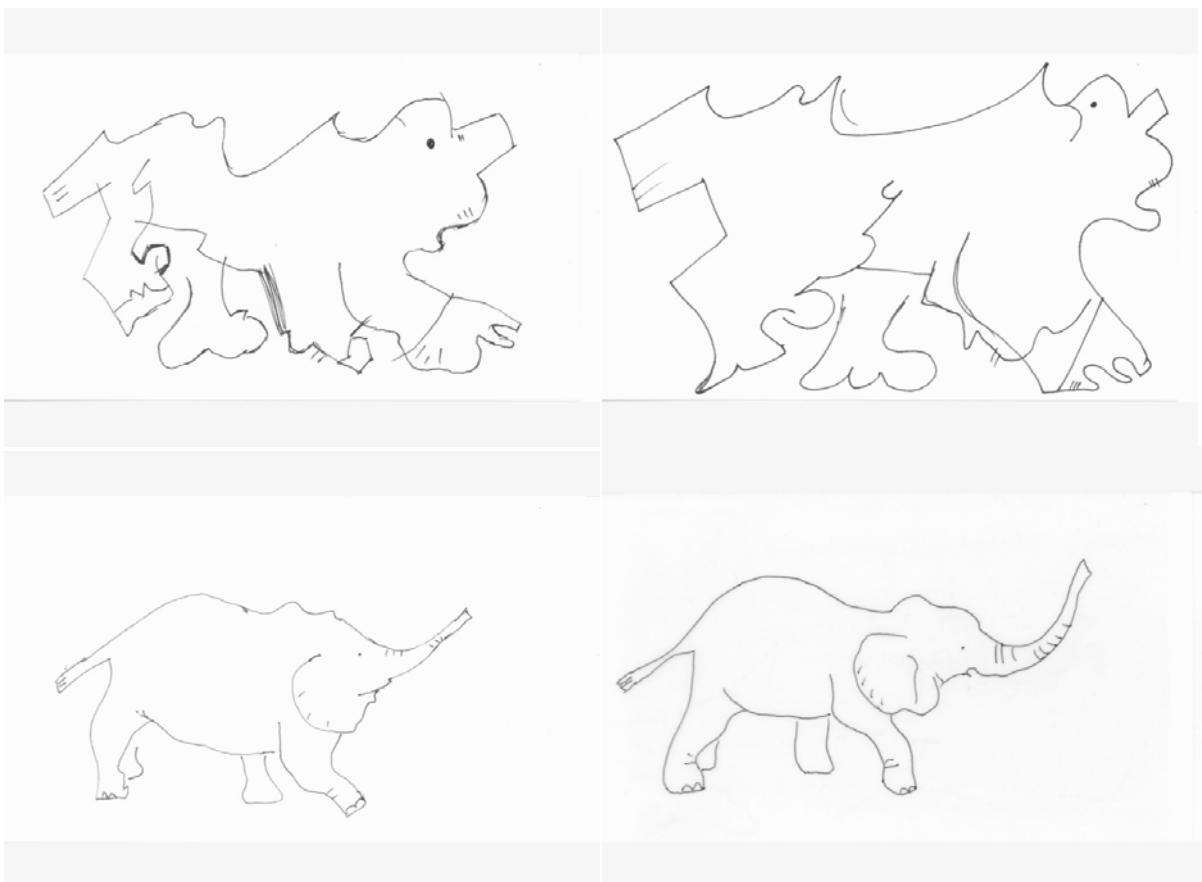
The first game is 'Chinese whispers' - English name for 'broken telephone' - played with drawings. It begins with a drawing I make of a familiar object. Another person copies my drawing, and another copies theirs, and so on. Each person sees only the drawing they copy, not the preceding sequence, and the instruction is to copy faithfully what you see. Most of the participants are not art trained so inaccuracies accumulate and the image gradually loses its representational meaning.

The second game can be played with one person at a time or several. I show them the drawings in reverse sequence and they try to guess what it represents.

In the psychology experiment this second game was formalised to compare how quickly viewers made meaning from different sorts of drawings.

### Biography

Rachel Cohen works in drawing and painting, photography, animation, sound, and text. She creates events and art works that invite public participation and that take the form of games. Her research combines teaching and community engagement with innovative science research in partnership with psychologists. She is based in Brighton UK.



## Possibilities v1.1

Nick Sousanis | Columbia Teacher's College | spinweaveandcut.com | nsousanis@gmail.com

### Biography

Nick Sousanis cultivates his creative practice at the intersection of image and text. A doctoral candidate at Teachers College, Columbia University, he is writing and drawing his dissertation entirely in comic book form. Before coming to NYC, he was immersed in Detroit's thriving arts community, where he co-founded the arts and cultural web-mag [www.thedetroiter.com](http://www.thedetroiter.com); served as the founding director of the University of Michigan's Work:Detroit exhibition space, and became the biographer of legendary Detroit artist Charles McGee. His comics have been infiltrating the academic realm through numerous publications and he furthers his advocacy for the medium in the comics course he developed for educators at Teachers College. Tw: @nsousanis

# POSSIBILITIES v1.1

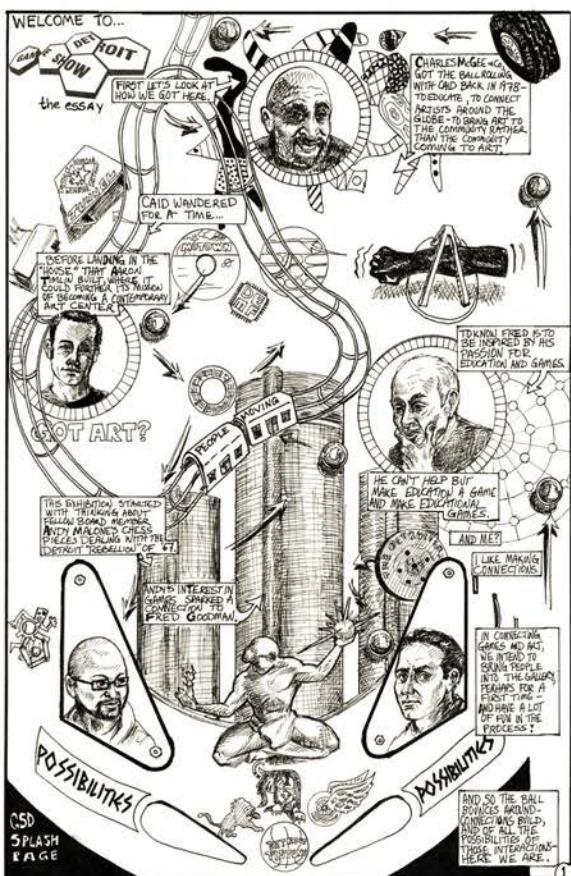
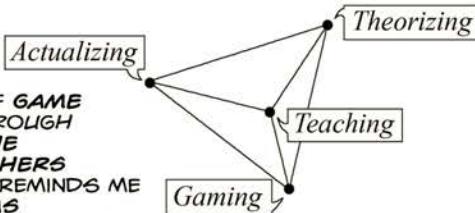
by

Nick Sousanis

IN 2006, FRED GOODMAN, ANDY MALONE, SAMBLUDDHA SAHA, AND I ORGANIZED *GAME SHOW DETROIT* AT THE CONTEMPORARY ART INSTITUTE OF DETROIT (CAID), AN EXHIBITION CENTERED ON "GAMING AS A CATALYST FOR APPRECIATING ART AND BUILDING COMMUNITY." AFTER A BIT OF A NUDGE FROM ANDY TO DO THE EXHIBITION ESSAY IN COMIC BOOK FORMAT, I CREATED "POSSIBILITIES," WHICH AS I FOLLOWED MY RESEARCH JOURNEY WHERE IT LED, ENDED UP BECOMING A CONTEMPLATIVE PIECE ON THE NATURE OF GAMES AND A MEANS OF RETHINKING OUR OWN OUTLOOK THROUGH THE PHILOSOPHICAL FRAMING GAMES PROVIDE.



THIS REVISED "POSSIBILITIES" VERSION 1.1 (ORIGINAL COVER IMAGE ABOVE-RIGHT AND DETROIT-CENTRIC FIRST PAGE BELOW) IS PUBLISHED TO COINCIDE WITH THE OCCASION OF *GAME SHOW NYC*, A CELEBRATION OF "THE ART OF LEARNING THROUGH GAMES," AND THE CONFERENCE *CREATIVITY, PLAY, AND THE IMAGINATION ACROSS DISCIPLINES*, BOTH HELD AT TEACHERS COLLEGE, COLUMBIA UNIVERSITY. AS I WRITE THIS, FRED REMINDS ME OF THE FOLLOWING PASSAGE FROM JOHN DEWEY IN *ART AS EXPERIENCE*, "A PRIMARY TASK ... IS TO RESTORE CONTINUITY BETWEEN THE REFINED AND INTENSIFIED FORMS OF EXPERIENCE THAT ARE WORKS OF ART AND THE EVERYDAY EVENTS, DOINGS AND SUFFERINGS THAT ARE UNIVERSALLY RECOGNIZED TO CONSTITUTE EXPERIENCE."



WORKING ON "POSSIBILITIES" TOLCHED OFF AN EXPLORATION FOR ME OF USING THE VISUAL-VERBAL MEDIUM THAT IS COMICS AS A MEANS OF EDUCATION, AND CONTRIBULITG TO A TRANSFORMATION OF THE ONCE LOWLY REGARDED COMIC BOOK INTO SOMETHING THAT IS, AS FRED PLITS IT, "BOTH EMINENTLY PRACTICAL AND ACADEMICALLY RESPECTABLE." ULTIMATELY, THIS SPEAKS TO THE IDEA THAT OTHER FORMS OF SEEING, OF THINKING, BEYOND STRICTLY VERBAL, ARE LEGITIMATE AND NECESSARY TO FULLY EXPLORE WHO WE CAN BE. AS DEWEY WROTE LONG AGO, "THE ARTS WHICH TODAY HAVE MOST VITALITY FOR THE AVERAGE PERSON ARE THINGS HE DOES NOT TAKE TO BE ARTS: FOR INSTANCE, THE MOVIE, JAZZED MUSIC, THE COMIC STRIP..."



I'D LIKE TO THINK  
DEWEY WOULD ENJOY THIS.

- NICK SOLISANIS  
MAY 20, 2011

NSOLISANIS@GMAIL.COM  
SPINWEAVEANDCLIT.COM



Game Show Logos  
by Andy Malone

© NICK SOLISANIS  
2006, 2011

1

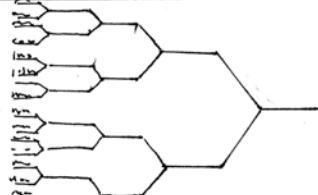


IN BUILDING A DEFINITION OF JUST WHAT WE MEAN BY A "GAME" WE MIGHT FIRST START BY SAYING WHAT'S NOT.

A PUZZLE IS LIKE A GAME - BUT NOT...



PUZZLES CAN BECOME A GAME WHEN PLAYED AS COMPETITION - A TOURNAMENT - THE OUTCOME BECOMES UNCERTAIN.



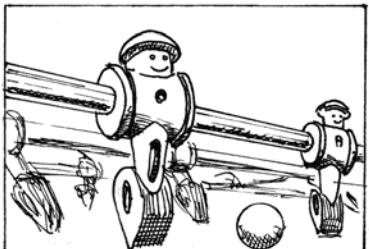
A GAME IS CHARACTERIZED BY UNCERTAIN OUTCOMES - MULTIPLE POSSIBILITIES.

AND WHAT OF SPORTS?

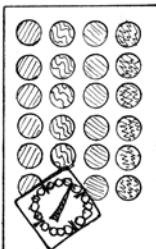


CONTESTS WITH INCREASED EMPHASIS PLACED ON ATHLETIC SKILLS - A PHYSICAL GAME.

IN ADDITION TO THIS PHYSICAL ASPECT, IN SPORTS THE PLAYER BECOMES BOTH PLAYER AS WELL AS PIECE TO BE PLAYED.

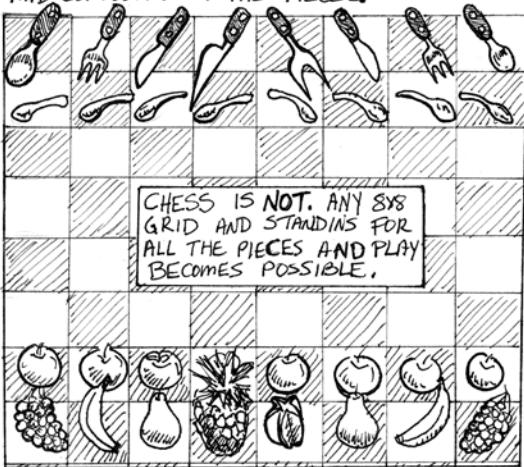


THOUGH THIS IS ALSO TRUE IN GAMES LIKE TWISTER, BUT IS TWISTER A SPORT? THE DISTINCTION IS TRICKY - LIKE DECIDING WHETHER A TOMATO IS A FRUIT.



PERHAPS THEN, THE MOST WE CAN SAY IS THAT SPORTS ARE A SPECIAL, IF OFTEN OVERLAPPING SUBSET OF THE WIDE WORLD OF GAMES.

FURTHERMORE SPORTS MIGHT BE DELINEATED FROM GAMES IN TERMS OF BEING ARTIFACT DEPENDENT - THAT IS PLAY DEPENDS ON THE SHAPE AND COMPOSITION OF THE PIECES.



CHESS IS NOT ANY 8x8 GRID AND STANDING FOR ALL THE PIECES AND PLAY BECOMES POSSIBLE.



BASKETBALL, HOWEVER, IS VERY MUCH DEPENDENT ON THE SHAPE & COMPOSITION OF THE PIECES.

3



THIS SORT OF PLAY HAS A FORM OF ORGANIZATION IN PLACE. THERE IS A CLEARLY DEFINED OBJECTIVE AND THERE ARE RULES.

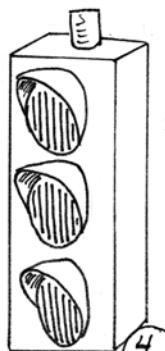
THE OBJECTIVE IS A GOAL - A STATE WHEN WE KNOW THE GAME IS OVER, OR WHEN IT'S OVER - SAY OUT OF TIME - IT'S REACHED SOME OBSERVABLE OUTCOME.

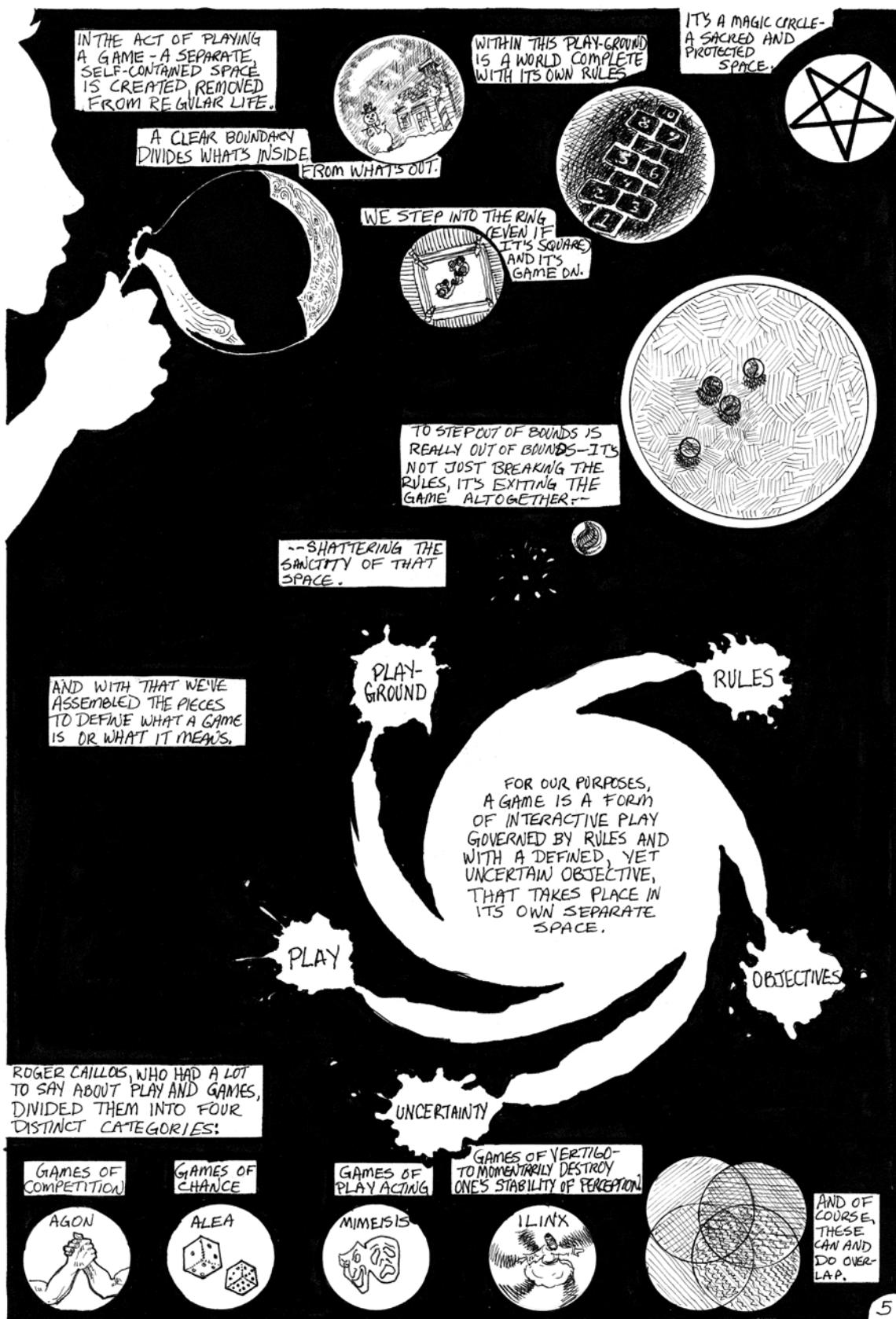
RULES PROVIDE A STRUCTURE - A FRAMEWORK TO PLAY THE GAME WITHIN.

RULES DEFINE WHAT IS FORBIDDEN.

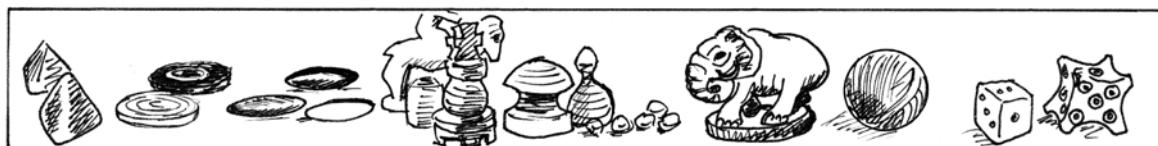
WHAT IS PERMITTED

AND WHAT IS REQUIRED.

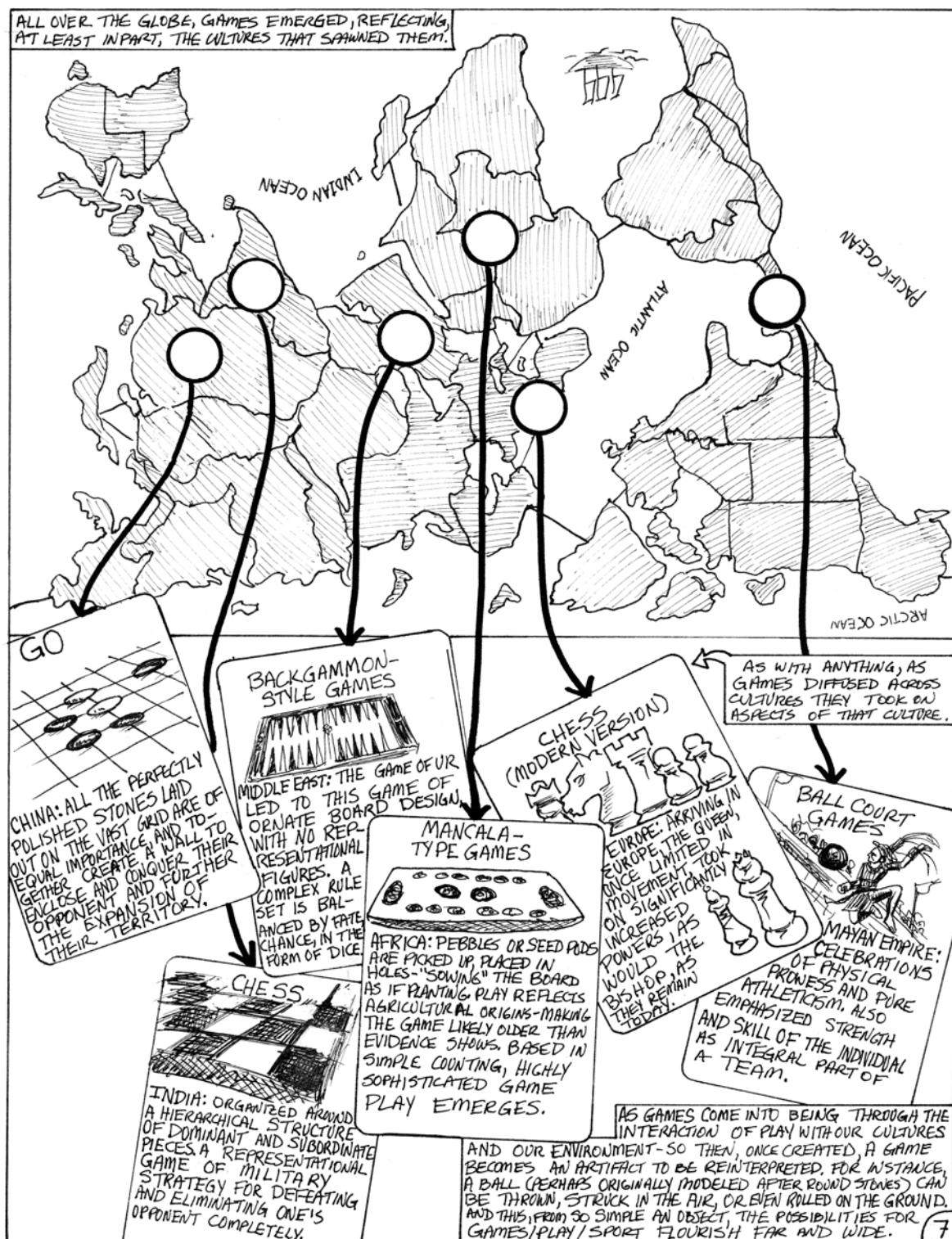


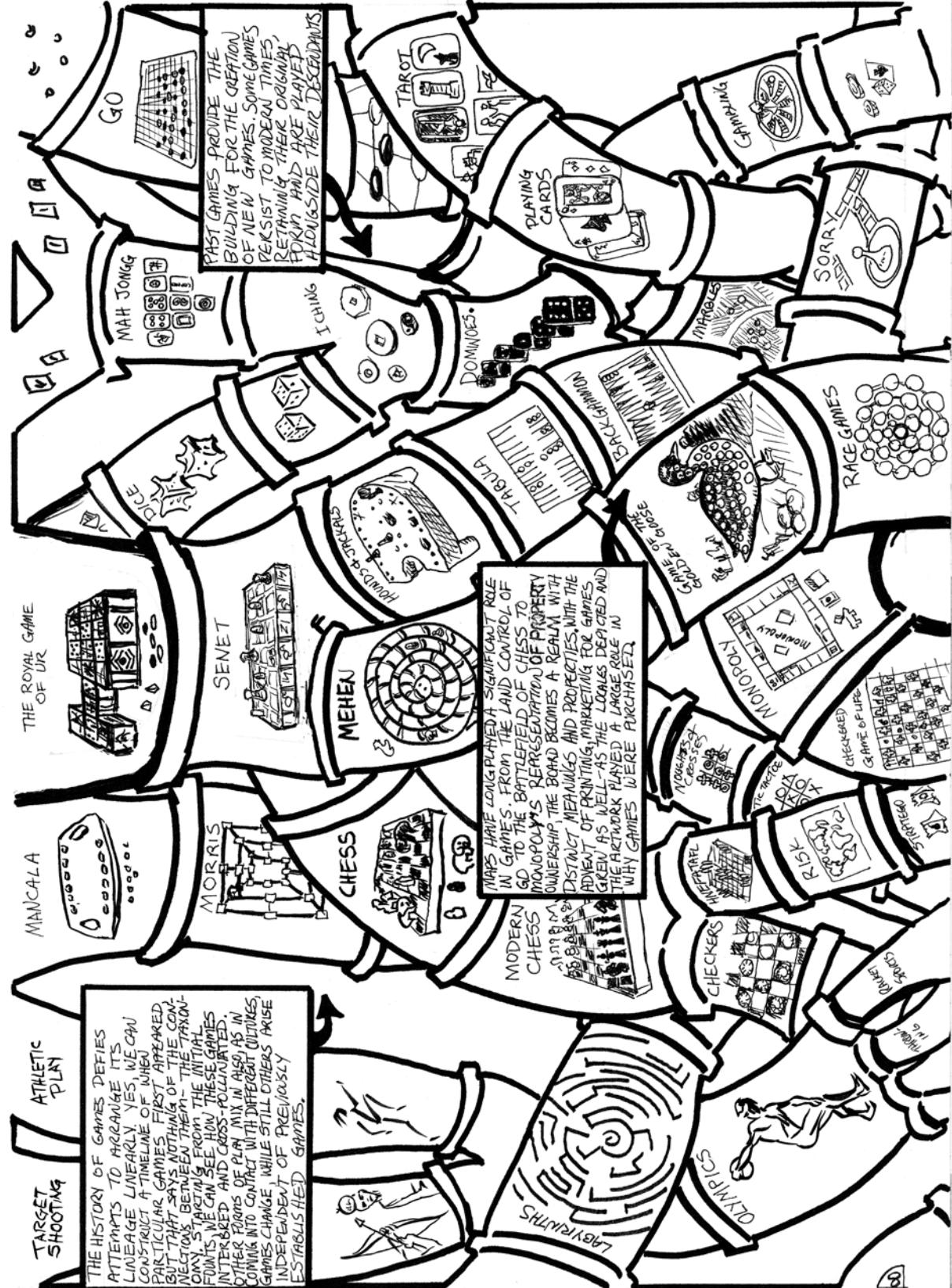


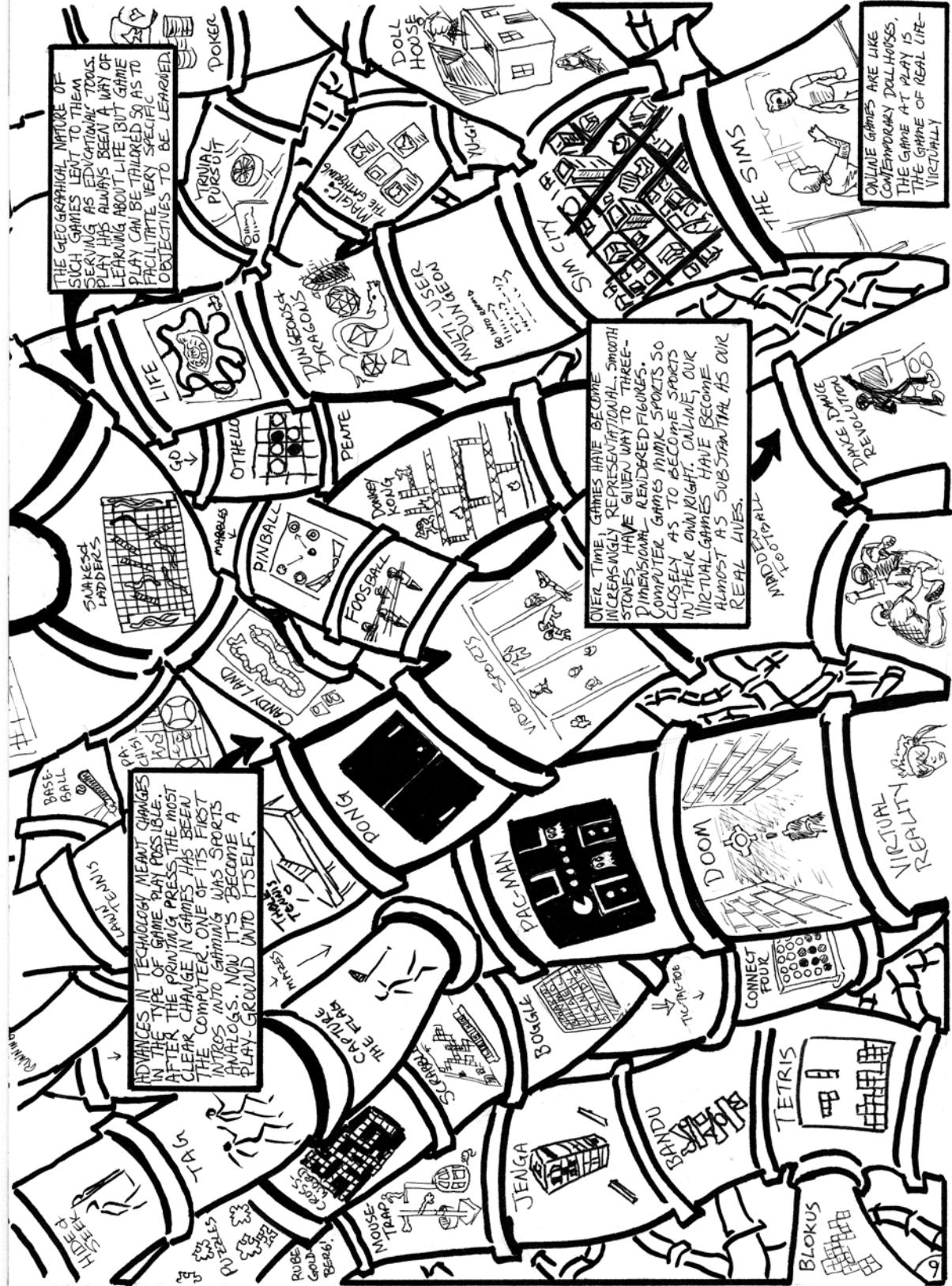




ALL OVER THE GLOBE, GAMES EMERGED, REFLECTING, AT LEAST IN PART, THE CULTURES THAT SPAWNED THEM.







IN THE LATE 1960S, MATHEMATICIAN JOHN CONWAY SOLVED MATHEMATICIAN JOHN VON NEUMANN'S CHALLENGE OF A GAME THAT COULD PLAY ITSELF.



THIS PATTERN REMAINS STATIC - NO DEATHS, NO BIRTHS.

AS DOES THIS ONE.

A ZERO PLAYER GAME.

HE TERMED IT THE "GAME OF LIFE"

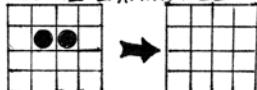
THE GAME IS PLAYED ON AN INFINITE GRID - PIECES OCCUPYING A SQUARE REPRESENT A "LIVE" CELL. THE RULES OF LIFE, DEATH, AND BIRTH ARE AS FOLLOWS:

FOR "POPULATED" SPACES -

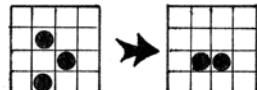
EACH CELL WITH 1 OR 0 NEIGHBORS DIES - "LONELINESS"  
EACH CELL WITH 4 OR MORE NEIGHBORS DIES - "OVERCROWDING".

EACH CELL WITH 2 OR 3 NEIGHBORS SURVIVES.  
FOR AN EMPTY, "UNPOPULATED" SPACE  
EACH CELL WITH EXACTLY 3 NEIGHBORS BECOMES POPULATED - A "BIRTH".

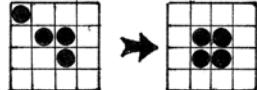
SOME EXAMPLES



BOTH CELLS "DIE" NO BIRTHS

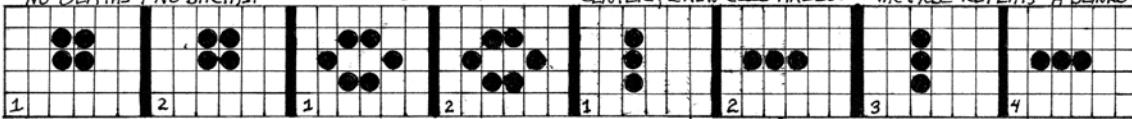


2 DEATHS, ONE BIRTH, BUT SEE ABOVE FOR NEXT ROUND.

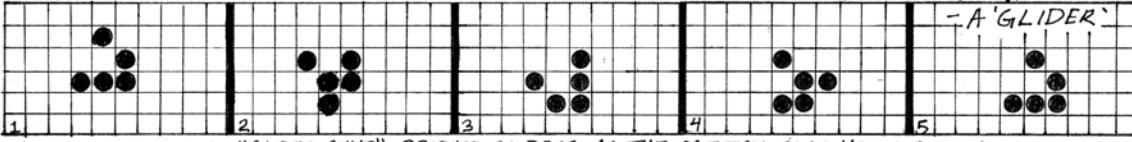


ONE DEATH, ONE BIRTH

HERE THE UPPER AND LOWER CELLS DIE, WHILE LEFT AND RIGHT OF CENTER, 2 NEW CELLS ARE BORN - THE CYCLE REPEATS - A "BLINKER".

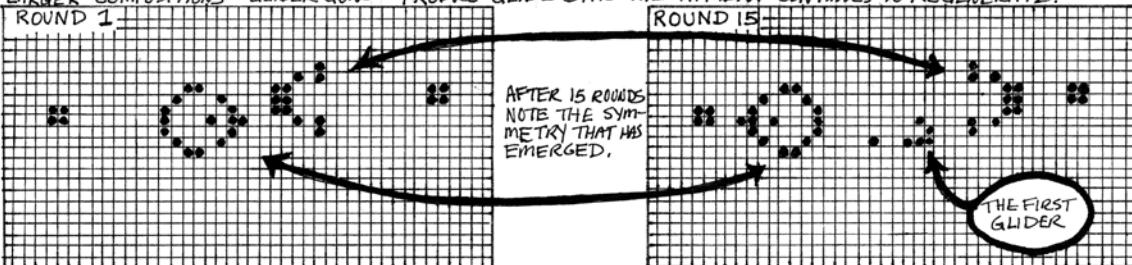


THIS PATTERN LOSES AND GAINS CELLS, BUT RETURNS TO ITS ORIGINAL PATTERN THOUGH ONE SPACE HORIZONTAL AND VERTICAL.



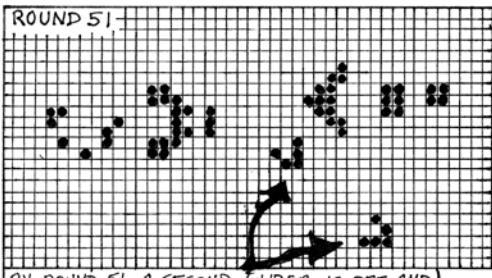
- A "GLIDER".

LARGER COMPOSITIONS - "GLIDER GUNS" - PRODUCE GLIDERS, AS THE PATTERN CONTINUES TO REGENERATE.



AFTER 15 ROUNDS  
NOTE THE SYMMETRY THAT HAS  
EMERGED.

THE FIRST  
GLIDER



BY ROUND 51, A SECOND GLIDER IS OFF AND RUNNING AND THE CYCLE CONTINUES.

ZOOMING HIGH ABOVE THE GRID,  
WITNESS THIS STABLE PATTERN  
OF GLIDER GUNS AND MORE  
WHICH PRODUCES GLIDERS,  
AND CONTINUALLY JETISONS  
THEM OUTWARD.

↑  
GLIDERS

↑  
GLIDERS

THIS IS AT ONCE QUITE AN  
ABSTRACTION, YET STRIKINGLY  
REPRESENTATIONAL OF SOMETHING  
QUITE ORGANIC, PERHAPS  
EVEN, DARE WE SAY IT, LIFELIKE.

HMM... SO THEN...

(10)

LET'S THINK ABOUT LIFE AND THE UNIVERSE AS WE'VE COME TO UNDERSTAND IT IN THE CONTEXT OF CONWAY'S "GAME OF LIFE," AND OUR DEFINITION OF GAMES.

AS A PLAY-GROUND, WE HAVE THE UNIVERSE ITSELF.

$$F_g = Gm_1 m_2 / R^2$$

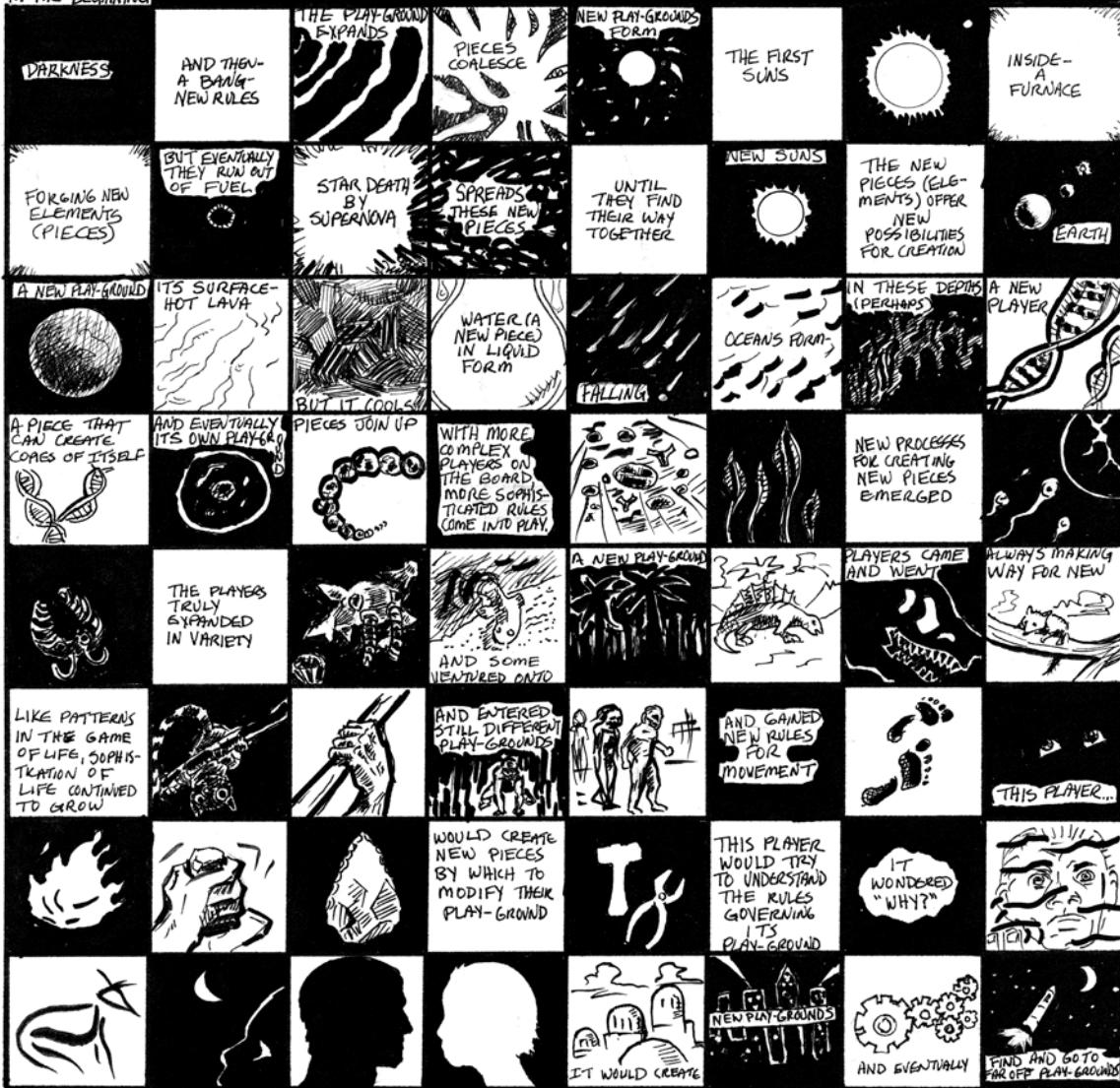
$$E = mc^2$$

AND FOR RULES - WE HAVE THE LAWS OF PHYSICS - ALL OF THIS SET IN MOTION BY WHAT GAMERS TERM...

A GAME OVERALL DIRECTOR.

NOW LET'S PLAY.

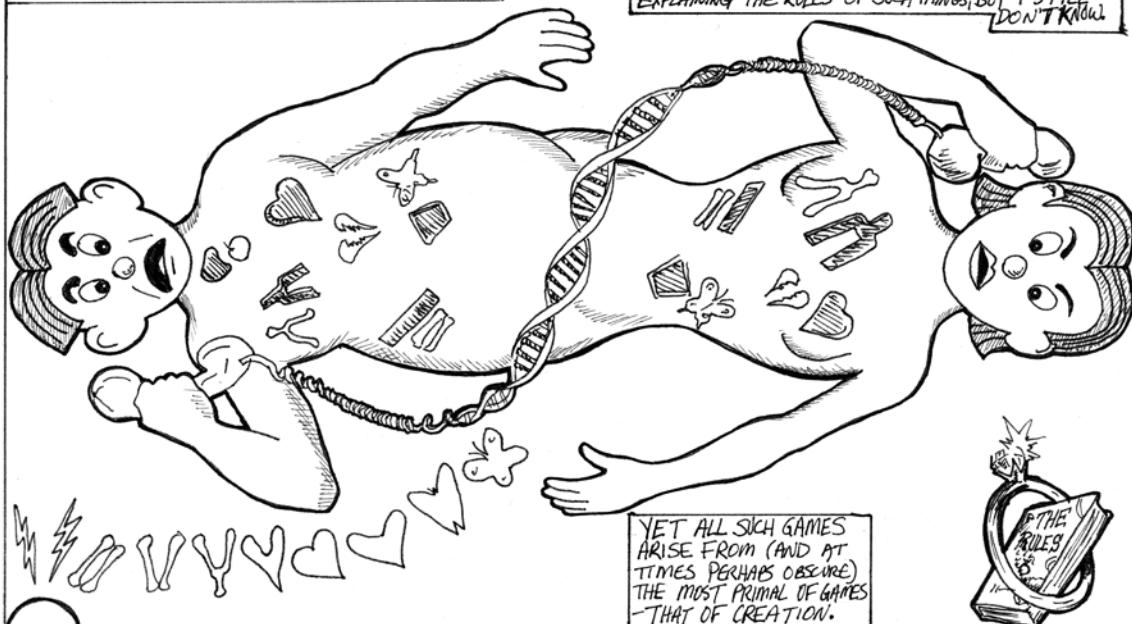
IN THE BEGINNING,



THIS PLAYER - THIS HUMAN BEING - DIDN'T JUST PLAY THE GAME PUT IN MOTION AT THE OUTSET, BUT CREATED GAMES ALL THEIR OWN.

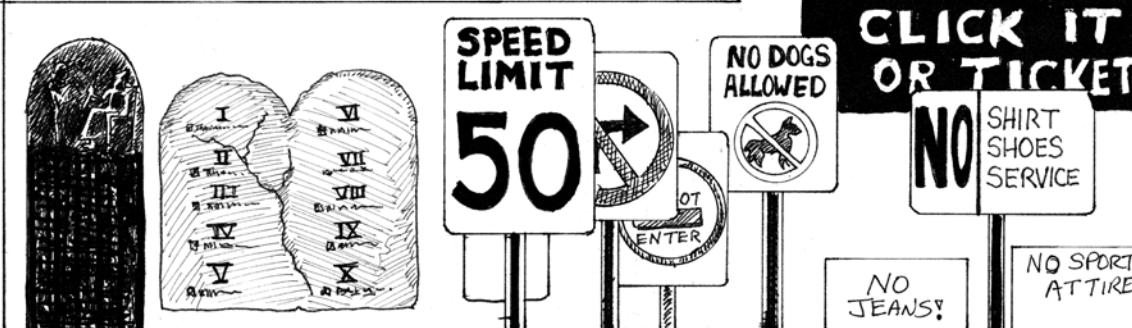
OUR GAMES CONTINUE TO GROW IN COMPLEXITY.  
WE PLAY "MIND GAMES" AND "HEAD GAMES" ALL  
IN PURSUIT OF GAMES OF THE HEART.

THE DATING GAME BECOMES THE TELEPHONE GAME -  
AND JUST HOW LONG SHOULD I WAIT TO CALL?  
2 DAYS? 3 DAYS? A WEEK? NEVER? THERE'RE BOOKS  
EXPLAINING THE RULES OF SUCH THINGS, BUT I STILL  
DON'T KNOW.



YET ALL SUCH GAMES  
ARISE FROM (AND AT  
TIMES PERHAPS OBSCURE)  
THE MOST PRIMAL OF GAMES  
- THAT OF CREATION.

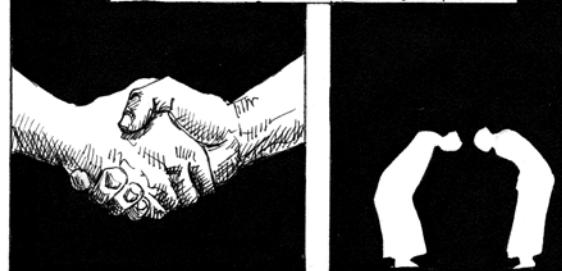
SINCE HAMMURABI'S TIME, WE'VE BEEN WRITING DOWN RULES TO  
FOLLOW AND POSTING THEM IN PUBLIC SPACES.



RULES BECOME CONVENTION-SHAPING HOW WE DRESS...



AND EVEN HOW WE GREET ONE ANOTHER.



SOCIETIES THEN ARE A  
COLLECTION OF RULES.

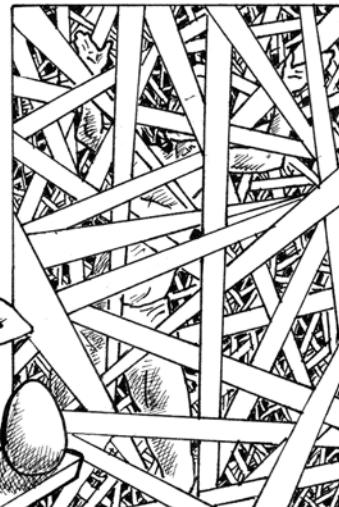
AND WHEN THESE  
SYSTEMS OF RULES  
COME INTO CONFLICT...



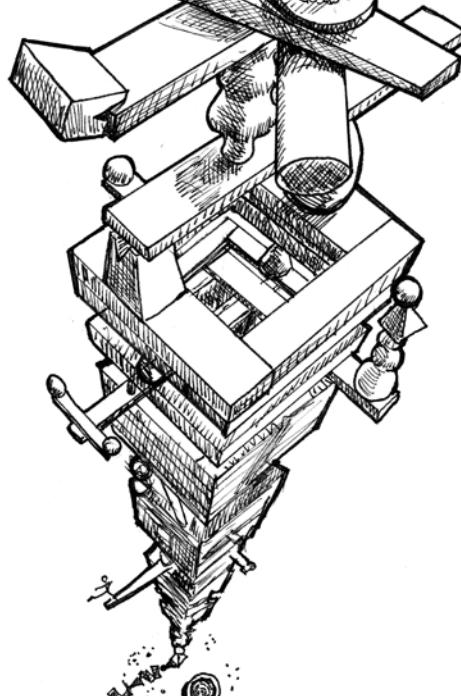
FOR MANY THE IDEA OF RULES IS NEGATIVE - RESTRICTIVE. YET WITH TOO FEW RULES CHAOS ENSUES.



OF COURSE, WITH TOO MANY RULES - NOTHING CAN HAPPEN - LIKE BEING BOUND BY RED TAPE. (GAMES OF THIS SORT MIGHT BE BILLED AS, "A LIFETIME TO LEARN, A LIFETIME TO MASTER.")



WE NEED TO FIND BALANCE BETWEEN TOO MANY AND TOO FEW RULES. TO WALK THAT EDGE BETWEEN CHAOS AND STASIS.



RULES THEN DON'T RESTRICT, BUT ARE NECESSARY AND MAKE THINGS POSSIBLE.



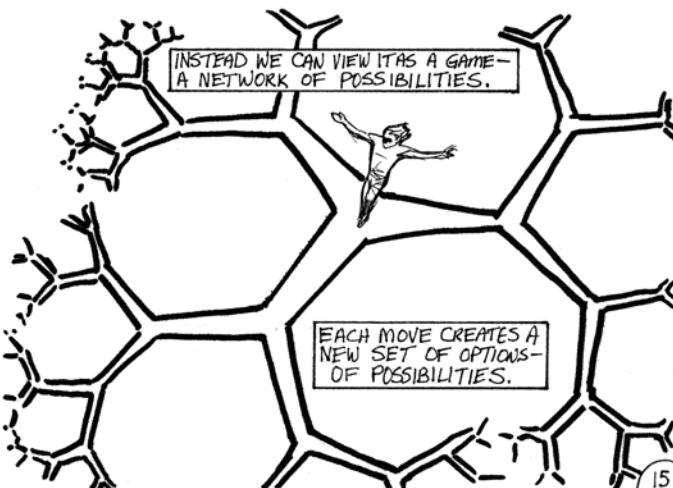
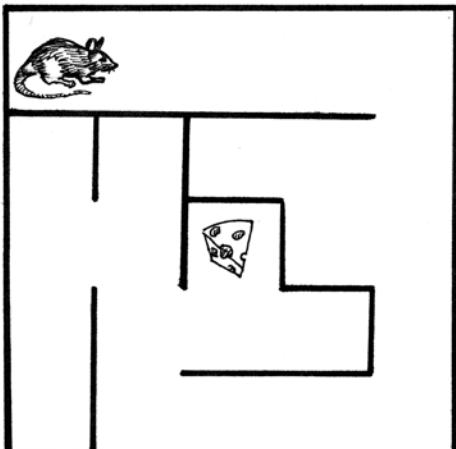
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ART IS A PRODUCT OF RULES, A SERIES OF OBJECTIVES LACED WITH UNCERTAINTY AND FILLED WITH POSSIBILITY, EXISTING IN ITS OWN PLAY-GROUND.  
THIS COMIC BOOK IS NO EXCEPTION.



FURTHERMORE, IF WE THINK OF THE PLAY OF CHILDREN AS TENDING TO BE TOO CHAOTIC, AND THAT OF THE ADULT AS TOO RIGID, THE CREATIVE THINKER IS THEN, AS HOWARD GARDNER WRITES, "SOMEONE WHO POSSESSES A MIND THAT IS YOUNG AND MATURE." THROUGH GAMES - THE ACT OF PLAY - WE CAN KEEP THAT BALANCE.

WE CAN APPLY THIS TO HOW WE LEARN - EDUCATION NEED NOT BE THOUGHT OF AS A PUZZLE WITH BUT A SINGLE, PREDETERMINED SOLUTION.



I HAD AN OBJECTIVE FROM THE OUTSET: TO HELP THE READER TO BETTER UNDERSTAND AND APPRECIATE THE POWER OF GAMES AND PLAY.

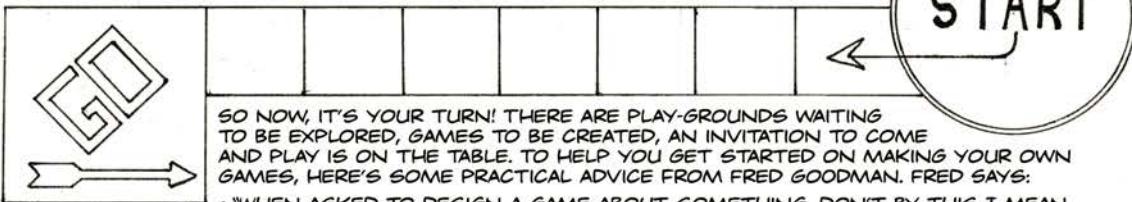
I WORKED WITHIN THE ESTABLISHED RULES OF COMICS - THERE ARE CONVENTIONS OF THE MEDIUM ITSELF - THE PLAY-GROUND, AND ALSO A FEW ADDITIONAL SELF-IMPOSED GUIDELINES PARTICULAR TO THIS PROJECT. THIS NARRATIVE WOULD HAVE NO (OR ALMOST NO) HUMAN FIGURES AND FURTHERMORE, I WOULD NOT DEPICT MYSELF AS NARRATOR (A CONVENIENT TRICK - IT ALWAYS GIVES ME SOMETHING AT HAND TO DRAW!)

IN THE PLAY OF THIS GAME OF ART WITH THE OUTSIDE WORLD UNEXPECTEDS Popped UP. THE UNEXPECTED HAPPENED AS THINGS LIKE RABBITS, CERTAINLY NOT CALLED FOR BY MY OBJECTIVE, SNICK INTO THE NARRATIVE AND NEARLY OVERRAN THE WHOLE THING. THIS IS WHAT MAKES THE GAME SO ENGAGING - THAT BALANCE BETWEEN INTENTIONALITY AND CHANCE THAT LEADS TO RICH CREATION.

CHARLES McGEE TALKS OF PUTTING ONE'S SIGNATURE ON ANYTHING A PERSON CREATES. SUCH IS THE CASE WITH THIS EXHIBITION AS EACH ARTIST APPROACHED THIS SAME THEME - OF FUSING GAMES AND ART - AND ALL CREATED WILDLY DIFFERENT WORKS.

IN REMAINING OPEN TO THE WORLD YET TRUE TO THE RULE SET THAT DEFINES WHO WE ARE, IN PLAYING THE GAME OF ART, OF CREATIVITY, WE ARE LED ON A FABULOUS JOURNEY OF POSSIBILITIES.





SO NOW, IT'S YOUR TURN! THERE ARE PLAY-GROUNDS WAITING TO BE EXPLORED, GAMES TO BE CREATED, AN INVITATION TO COME AND PLAY IS ON THE TABLE. TO HELP YOU GET STARTED ON MAKING YOUR OWN GAMES, HERE'S SOME PRACTICAL ADVICE FROM FRED GOODMAN. FRED SAYS:

- "WHEN ASKED TO DESIGN A GAME ABOUT SOMETHING, DON'T, BY THIS I MEAN DON'T DESIGN IT ABOUT THE PARTICULAR PHENOMENON REQUESTED BUT RATHER DESIGN AN ENVIRONMENT IN WHICH THE PHENOMENON CAN BE EXPECTED TO PLAY A SIGNIFICANT ROLE. MY FAVORITE EXAMPLE IS THE MARBLE GAME I DESIGNED FOR DETROIT KIDS WHEN THE REQUEST WAS FOR A GAME ABOUT 'POLICE-COMMUNITY RELATIONS.' I JUST BUILT A MARBLE GAME AND ASSIGNED SOME OF THE KIDS TO PLAY THE ROLE OF THE POLICE, IN ORDER TO ENFORCE THE GAME'S RULES. ANOTHER KID WAS THE JUDGE AND OTHERS WERE THE GOVERNMENT, SO THE POLICE WERE SEEN IN CONTEXT AS THEY DEALT WITH MARBLE SHOOTERS, TARGET OWNERS, AND THOSE WHO MADE AND ULTIMATELY JUDGED RULES, ETC."
- "IT'S EASY TO DESIGN COMPLEX; IT'S MUCH HARDER TO DESIGN GOOD SIMPLE GAMES."
- "AS MUCH AS POSSIBLE, INCORPORATE RULES OR PARAPHERNALIA ASSOCIATED WITH FAMILIAR GAMES IN THE GAME YOU'RE DESIGNING IN ORDER TO MAKE THE RULES EASY TO QUICKLY UNDERSTAND."
- "A SIMPLE DEVICE IS TO COMBINE TWO FAMILIAR GAMES."
- "DESIGNING GAMES IS LIKE LEARNING TO WALK; I.E. PUTTING WEIGHT FIRST ON ONE LEG, THEN ON ANOTHER. BY THIS I MEAN TAKE TURNS CONSIDERING FIRST, WHAT GAME MODEL OR MATERIALS YOU MIGHT WANT TO USE, AND SECOND, WHAT YOU ARE TRYING TO GET ACROSS VIA THE GAME. BUT DON'T CONCENTRATE ON ONE OR THE OTHER TOO LONG... GO BACK AND FORTH AS OFTEN AS POSSIBLE."

 KEY TO SELECT IMAGES. PAGE 2, PANEL 1: TRIX THE CEREAL RABBIT. P2: THE WHITE RABBIT, "ALICE IN WONDERLAND." P3: PETER RABBIT, BEATRIX POTTER TALES. P4: ? P5: THUMPER, BAMBI. P6: JESSICA RABBIT, WHO FRAMED ROGER RABBIT? P7: JACKALOPE. P8: UNCLE WIGGILY. P9: PAT THE BUNNY. P10: PLAYBOY BUNNY. P11: LUCKY RABBIT'S FOOT. P12: MIFFY, BY DICK BRUNA. P13: BRER RABBIT. P14: CHOCOLATE RABBIT - YUMM! P15: ENERGIZER BUNNY. P16: RABBIT IN HAT. P17: EASTER BUNNY. P18: HAND SHADOW RABBIT. P19: VELVETEEN RABBIT - REAL. P20: VELVETEEN RABBIT - ALIVE. P21 (LEFT TO RIGHT): 1) RABBIT, "WATERSHIP DOWN," 2) RABBIT, WINNIE THE POOH, 3) PETER COTTONTAIL, 4) CAPTAIN CARROT, 5,6,7) FLOPSY, MOPSY, & COTTON TAIL - BEATRIX POTTER TALES, 8) BONGO, "LIFE IN HELL," 9) MARCH HARE, ALICE..., 10) YUSAGI YOJIMBO, 11) FRANK, DONNIE DARKO, 12) JIMMY "BUNNY RABBIT" SMITH - EMINEM, "8 MILE," 13) BUGS BUNNY. NOTE - THE RABBITS PER ROW NUMBER 1, 1, 2, 3, 5, 8, WITH 13 RABBITS IN THE FINAL PANEL. THIS IS THE FAMOUS FIBONACCI SEQUENCE - ORIGINALLY CONCEIVED TO ESTIMATE THE GROWTH OF ... RABBIT POPULATIONS!

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