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From Edutainment to Serious Games: A Change in the Use of Game Characteristics

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Abstract

Serious games use instructional and video game elements for nonentertainment purposes. Serious games attempt to create instructionally sound and relevant learning experiences for a wide variety of audiences and industries. The author contends that for serious games to be effective, instructional designers and video game designers need to understand how the game characteristics, competition and goals, rules, challenges, choices, and fantasy, used in both edutainment and serious games, can influence motivation and facilitate learning.

Keywords

games, edutainment, serious games, game characteristics, simulations

Edutainment and instructional computer games were once touted as the savior of education because of their ability to simultaneously entertain and educate. These types of computer-based instruction were lauded for effectively and efficiently teaching all levels of students a variety of subjects (Alessi & Trollip, 2001; Gredler, 2003; Gros, 2003; Hannafin & Peck, 1988). Yet, both edutainment and instructional computer games have received a terrible reputation for being the worst type of education, drill and practice activities masked with less than entertaining game play (Van Eck, 2006).

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Seymour Papert (1998) referred to edutainment and instructional computer games as Shavian reversals. Shavian reversals are offspring that keep the worst traits of the parents and lose the good traits. Edutainment is the combination of one of the lowest forms of education (drill and practice) with less than entertaining game play. As video games have progressed from the simplistic (Pac-Man, Space Invaders) to complex (Civilization IV, EverQuest) and education has emphasized more constructivist learning methods, there has been a parallel progression from developing edutainment to creating serious games.

In the last few years, there has emerged a serious game movement and perspective regarding the use of both computer and video games for nonentertainment purposes (i.e., public policy, education, business, health care, military; Becker, 2005; Sawyer, 2006). Some have supported and encouraged the design and development of serious games (Aldrich, 2004, 2005; Gee, 2003, 2005; Prensky, 2001; Shaffer, 2005; Squire, 2002). There is no shortage of champions for creating serious games. What is needed is a framework for designing serious games that builds off of the edutainment and instructional games research. Although many edutainment and instructional computer games are lacking in sophistication, depth of learning, and game play, they offer a foundation for analyzing why and how games enable learning which can inform the design of serious games.

Games, board, card, edutainment, or serious, can be defined as playful activities, with or without a computer, that have essential characteristics (Dempsey, Lucassen, Haynes, & Casey, 1996). Game characteristics can include competition and goals, rules (Alessi & Trollip, 2001), challenging activities (Malone & Lepper, 1987; Rouse, 2005), choices (Hannafin & Peck, 1988), and fantasy elements (Cruickshank & Telfer, 1980; Lepper & Cordova, 1992). The game characteristics enable the formalization of play by transforming play from a free form activity to a structured, organized activity that is still fun (Crawford, 2003; Koster, 2005). Every game uses these characteristics and that is the reason why many games are similar, but different. For example, Civilization III and Age of Empires are both strategy games that use the game characteristics in similar manners yet they are completely different games. The same can be said for other game genres, such as; racing games, fighting games, role playing games (RPGs), and so on. The characteristics are core to the game design but are used in varying ways to create a unique game experience (Rollings & Adams, 2003; Rouse, 2005).

The characteristics can be used in different ways because each characteristic operates on a continuum that offers a plethora of opportunities for innovative game design that facilitates learning. The characteristics can be used to design a fast paced, adrenaline pumping game. The same characteristics can also be used to create a game that evokes a sense of despair much like movies can leave an audience heartbroken (Appleman & Wilson, 2004; Rollings & Adams, 2003; Rouse, 2005). The possibilities are endless, yet most edutainment titles use the game characteristics to motivate the learner to complete learning activities, the more learning activities they complete the more entertainment they receive. This "carrot and stick"

approach while valuable for some types of learning (facts, rote memorization) is not sufficient for other types of learning (flexible, complex understanding).

Serious games use the characteristics to provide learners with an authentic learning experience where the entertainment and learning are seamlessly integrated (Gee, 2003, 2005; Prensky, 2001). Serious games use the characteristics but in a manner that allows for the use of a broader range of instructional methods. The dramatic shift in design of instructional games from edutainment to serious games while using the *same game characteristics* requires a reanalyzing of the game characteristics to determine how learning can occur in serious games (Dickey, 2005).

In this article, each characteristic will be examined to determine how each potentially influences learning. Current serious games, commercial video games, and hypothetical games will provide examples of how each characteristic is, or could be, used in a serious game. The reanalysis will focus on using characteristics in game, not designing instructional activities around a game. Although the integration of commercial and serious games instructional environments is extremely important, that topic is beyond the scope of the reanalysis (Van Eck, 2006).

Differences Between Games and Simulations

Games and simulations are very similar, which makes it difficult to discern a game from a simulation. Furthermore, many games contain a simulation engine, yet a simulation typically will not use some key game features, such as fantasy. Simulations are typically characterized by the roles or responsibilities the gamer takes on. Typically, roles and responsibilities evolve because of gamers' actions on dynamic, related variables. Simulations can be either experiential or symbolic (Gredler, 1996). Experiential simulations place learners in a professional role (i.e., doctor, lawyer) that requires decision making in a changing problem state to accomplish tasks or goals. Symbolic simulations place the gamer in a context where they are free to experiment with different strategies and/or confront misconceptions to explain events, principles, or best practices. Symbolic simulations may be constructed so students can learn about the unobservable (i.e., subatomic particles), work with dangerous materials free from harm (i.e., hydrochloric acid), and time can be sped up or slowed down to facilitate learning (Alessi & Trollip, 2001; Gredler, 1996). Simulations, both symbolic and experiential, are very context-specific, whereas games do not, necessarily, need to be context-specific; rather they can have very fantastical contexts, characters, scenarios, and so on. Because most simulations lack the fantasy element akin to games, they tend to be geared toward learners practicing in a specific context. Flight simulators are a prime example of a context-specific simulation. Yet, flight simulators have been made into games. Microsoft Flight Simulator is a popular game based on a flight simulation engine. The Civilization series and the various Tycoon games are also driven by a simulation engine. Yet these games are more game than simulation because they use the game characteristics, mostly competition and fantasy, to create an entertaining game experience.

Symbolic and experiential simulation have or could be used to train grocery ''bag boys,'' bank tellers, salespersons, teachers, negotiators, and many others. Experiential and symbolic simulations facilitate learning basic skills through the simulation activities and teach higher order complex thinking skills through replicating the context and aspects of the ''real'' world. Integrating in the game characteristics may add motivational impetus and engaging elements that could assist in facilitating learning (Aldrich, 2004, 2005;Alessi & Trollip, 1991, 2001; Gredler, 2003; B. Herz & Merz, 1998).

Edutainment

Some games use all the game characteristics; some use only a few or use them in varying degrees along each characteristic's continuum. The use of the characteristics has evolved due to improvements in game design and technology. Edutainment is a type of computer-based instruction designed to motivate the gamer using the characteristics (Hannafin & Peck, 1988). A classic edutainment game is ''Where in the world is Carmen Sandiego?'' (Broderbund, 1985).

In this game, the gamer is a gumshoe detective who must catch the slyest of the thieves, Carmen Sandiego. Carmen leaves various clues the gamer must decipher to identify Carmen's next geographic location. The clues are mostly true facts about real geographic locations and deciphering the clues assists the gamer in learning geographic locales. The game play in Carmen Sandiego is typical of edutainment; drill and practice activities disguised as games. Yet, there is nothing wrong with these drills masked as games; they teach the predetermined content, usually lower order thinking skills, extremely well (Collins, 1996).

Teaching lower order thinking skills, facts, concepts, and procedures are essential to fields of study, but typically that is all edutainment attempts to teach. Edutainment typically makes little or no attempt at trying to teach gamers how to apply their knowledge, analyze their understanding, synthesize their perceptions, or evaluate their learning; hence, the reason for Papert (1998) referring to them as ''Shavian reversals.''

Serious Games

The goals of most serious games are to facilitate gamers learning higher order thinking skills through using the characteristics to create game play that does not solely use masked drill activities. Making History (Muzzylane, 2006), Food Force (Deepend & Playthree, 2005), Virtual Leader (Simulearn, 2003), and Virtual U. (Virtual U, 2003) are a few serious games that attempt to facilitate learning their respective content beyond the lower order thinking skills and facilitate learning that involves higher order thinking skills. Virtual U is a serious game designed to facilitate students learning management practices for higher education institutions. Virtual U is a strategy game where the students manipulate a number of

administrative and management variables that have an impact on a fictional university. Virtual U is driven by an underlying simulation model that students must decipher through experimenting with setting the different variables and evaluating the results. There is no "right" way to play Virtual U, each student defines what a successful university is and can achieve success with a variety of strategies. One learner may feel a successful university is one that is well endowed and fiscally robust; another learner may define success as a university having a very satisfied and happy faculty and student body. Regardless of the learner's definition of success, students can learn the complexities of higher education administration while achieving vastly different goals. Many commercial strategy and "tycoon" games, such as Civilization, SimCity, Railroad Tycoon, use the same progressively challenging underlying model that must be deciphered in order for gamers to succeed to provide entertaining game play.

Virtual U facilitates learning complex management and administrative practices by creating a learning experience that situates students in an authentic role and context. Carmen Sandiego facilitates students learning world geography by situating the learner in a fictitious role and context where completing the learning activities advances the game. These two games have vastly different game play that provides different types of learning. Virtual U focuses on facilitating higher order thinking skills (management practices in higher education administration) and Carmen Sandiego focuses on the lower order thinking skills (identification of geographic facts). Yet each uses the *same game characteristics* albeit in very different ways. The difference in how the game characteristics are used in edutainment versus serious games demonstrates a major shift in educational game design and is the catalyst for the reanalysis.

Game Characteristics

The characteristics are inherently interdependent each melds with others and all have a similar overall purpose—motivate and excite the gamer. However, for purposes of the reanalysis, each will be discussed independently to distinguish each characteristic's continuum of unique qualities and benefits.

Competition and Goals

Competition and goals are similar and intertwined in many games. Some games have goals that are based on competition, that is victory conditions. In these games, competition and the goal typically involves pitting one player versus another, playing against the computer, or racing against the clock (Alessi & Trollip, 1991, 2001). For example, the objective of poker is to get the best hand or bluff your way to victory. In chess, the goal is to capture your opponent's king. In Pac-Man, the goal is to get the highest score by gobbling up dots before the ghosts eat you. Typically in edutainment, the game goals match the learning goals and competition is added to make the

learning enjoyable (Alessi & Trollip, 1991, 2001). Using competition is supposed to motivate learners to complete the game activities because they will want to win. The game activities, typically drill activities, are based on the educational goals. The competition is designed to motivate the learner to complete more drills. In the edutainment game "Number Munchers" (Minnesota Educational Computer Consortium, 1990), students are a "muncher" that must complete a series of math problems to increase their points, pass a level, and avoid the evil troggles. In one such series of problems, students must "munch" factors of three. Munching the correct answer scores the student points, munching the wrong answer and touching a troggle takes away one life. When the student "munches" the correct number it can be assumed that the student has learned, or is learning, the prescribed educational goal, in this case multiples of three.

In many commercial and serious games, the game goals and competition have expanded beyond pure win–lose victory conditions. Gamers can now decide their own goals for "winning" or achieving success (like Virtual U). Many of the latest commercial and serious games are designed to last longer in duration; depending on the amount of effort a gamer invests, it could take an individual several months to finish games such as ZooTycoon, SimCity, or Halo (Gee, 2003). The longer duration can provide learners with opportunities to achieve more complex learning goals, but it is not just the longer duration that makes the attainment of higher order learning possible.

Players can now become motivated to play through improving their avatar (virtual character), city, civilization, business, and so on to the highest level or their own goal. The goal of improving their avatar, city, civilization, business, and so on requires players to complete a number of different quests, set and achieve subgoals that advances them toward their ultimate goal, and collaborate with others; be it non-player characters (NPCs) or real human players. The gamers' efforts toward improving their avatar, city, civilization, business, and so on are rewarded with feedback that comes in varying forms and degrees of usefulness. Depending on the game, feedback could be gaining new tools, clothes, currency, access to new game spaces, people, or levels, or the very typical increase in points. The gamer interprets the feedback to be useful, or not, based on how that feedback contributes to their particular goals (Gee, 2003; J. C. Herz, 1997). In the serious game Virtual Leader (Simulearn, 2003), that is designed to facilitate learning leadership principles, players must effectively manage meetings to handle crisis, delegate responsibility, and empower employees. Learning the leadership principles is not a matter of choosing the correct principle; it involves the player managing and applying the principles to situations, each with differing NPCs and circumstances. The competition in Virtual Leader, and many other commercial and serious games, does not solely exist with achieving victory but is coupled with negotiating difficult situations, analyzing the feedback they receive, and applying this analysis to new, yet similar, situations. The basic form of competition—beat your opponent can and still exists; yet, these forms of competition can be made more difficult and more

authentic by involving real players via hooking up more control pads to the gaming console, having local area network (LAN) game parties or playing against thousands in massively multiplayer online games (MMOGs).

Including more humans could be used to increase the level of competition and/or the complexity. Many instructional methods seek to make instruction more authentic to help students develop flexible knowledge structure. To develop a flexible knowledge structure, many advocate the use of constructivism. The goals and values of constructivism, such as multiple perspectives, relevant, authentic problems, and active learning, are similar to the game play in many commercial and serious games. Serious games could fulfill many of the goals of constructivism and Dickey (2005) has linked constructivist methods to engaging experiences in commercial video games. Research into the fulfillment of constructivist learning theories and methods through serious games is needed.

Rules

Rules are constraints that limit the actions a gamer can and cannot take. In edutainment the rules are typically fixed and cannot be broken or changed. Rules are important for educational games because they can be set to represent reality or real phenomenon (Alessi & Trollip, 1991, 2001). For example, White (1984) created a game that exactly represented Newton's laws of motion. Students learned from the Newtonian game by successfully using the physics principles. In many edutainment titles, the rules are restrictive because edutainment typically only allows learners to practice specific skill sets. In Number Munchers, learning the rules results in learning the content; munching the correct number scores points; and munching the incorrect number takes away a life. The rules in many commercial and serious games have progressed from restrictive to emergent. Some commercial and serious games have rules that can be broken or changed by the gamer's actions. Edutainment games use programming that clearly defines the outcomes of a gamer's actions; there is no possible exception to the rules. As such, edutainment type games are ideal for facilitating learners achieving lower order thinking skills because the rule structure provides much practice on a skill set. As technology and game design evolved, it is feasible to intertwine simulation elements with game characteristics to create a flexible rule structure to facilitate higher order learning—not just using the game as a means to facilitate learning via practice. Some commercial and serious games integrate simulation into the game via complex underlying models that allow for an untold number of outcomes. These games allow gamers to play the same game many times and each time the gaming experience will be different. For example, you can never build the exact same city twice in "SimCity" (Maxis, 2003) or the same civilization in "Civilization" (Firaxis Games, 2001)—each time you play the experience is unique. Mark Prensky (2001) in his book Digital Game Based Learning tells the story of two military tank operators who overcame a dire situation when they were ambushed in Desert Storm I. The soldiers were outmanned and outgunned

and defeat seemed imminent. Instead, in a stunning move the tanks defeated the ambush—unharmed. When the two were asked how they were able to survive the harrowing situation, they explained that it was because they had done it in the simulator—*repeatedly*. If the tank simulator was like edutainment only allowing them to practice known maneuvers, they would have never survived. The flexible rule structure allowed the soldiers to learn new maneuvers and transfer that learning to the battle field. This same type of learning via a flexible rule structure is also evident in Virtual Leader.

In one Virtual Leader meeting, the gamer may easily sway some colleagues to his or her side. Yet, in another playing of the same meeting, the exact opposite could happen because the underlying model makes each situation similar, but different, each time. Students can learn more than intended because there is no "right" way to play and many ways to succeed. The flexible rule structure allows learners to explore the game space, test hypothesis, and fulfill goals in a variety of unique, sometimes, unanticipated ways. The great degree of flexibility and range of plausible paths to success helps learners develop a flexible knowledge base that can be applied to a variety of real world situations (Koster, 2005; Spiro, Feltovich, Jacobson, & Coulson, 1991, 1992).

The rules can also be interpreted as the amount of control or functionality given (Malone & Lepper, 1987; Hannafin & Peck, 1988). Essentially, the control a gamer has is determined by the rule structure. A very restrictive structure such as Pac-Man only allows a very few maneuvers. Conversely, a very flexible structure such as World of WarCraft allows a plethora of actions some that were not, or could not, be predetermined.

Advances in game design and technology have opened the doors to more complex learning environments that facilitate learners attaining a more flexible understanding compared to edutainment. Yet, research into the types of content best suited for serious games is needed. It seems that complex content aiming for higher order thinking is best suited, but does this mean that novice learners or learners without appropriate prerequisite knowledge will not be successful? Or, can the lower order thinking and prerequisite knowledge be designed into the flexible rule structure? Much research into the types of content and structuring of content and how the content integrates, or not, with flexible rule structures is needed. Research on constructivist learning theories and cognitively flexible hypertexts may provide guidance and a foundation due to the flexibility inherent in these instructional environments, yet they do not include any of the game characteristics.

Choice

Choice refers to the number of options and decisions a gamer has prior to and during game play (Hannafin & Peck, 1988; Malone & Lepper, 1987). Three different types of choice are expressive, strategic, and tactical.

Expressive choice. Expressive choices are those that the learner makes which may have little effect on learning, but can improve learner motivation. Expressive choice is typically applied toward a gamer improving their avatar, city, civilization, business, and so on. Expressive choices can allow the gamer to choose an avatar or entity (civilization, region), name an avatar or entity, pick a location on a map, type of audio or no audio, or go ''shopping'' by selecting clothes or other items (character's body type, gender, hair color). Giving the gamer control over these choices can lead to the gamer developing empathy for their avatar, city, civilization, business, and so on as well as develop a sense of pride in the accomplishments or developments made to their avatar, city, civilization, business, and so on. Gee (2003) refers to the development of empathy and pride as projective identity, because the gamer is infusing some or all of his or her personality into the avatar or entity. Developing projective identity can help learners to progress in the game because they want to improve their avatar or entity. Progressing in the game typically helps learners practice skills in different contexts or more complex situations (Aldrich, 2004). In a typical commercial or serious RPG the gamer progresses from early to late stages by completing tasks/quest/challenges. As the gamer completes the tasks/quest/challenges he or she is given feedback in the form of rewards that are seamlessly integrated and are valuable in the game context. Some rewards could be promotions, money, greater responsibility, various items and so on,; that not only reward the gamer for their efforts but also propel the gamer to new tasks/quests/challenges.

For example, in Star Wars Knights of the Old Republic (Lucasarts, 2003), which is based on George Lucas' Star Wars movies, the gamer begins as a young padawan (inexperienced Jedi) and moves up to Jedi Master by completing quests/tasks. Completing the quest/task gains the gamer money, weapons, vehicles, and Jedi powers; which open up more difficult quests/tasks in new contexts, that is planets. When the young padawan fails at a task, they can simply pick up where the game, or they, last recorded their progress and try again or try another quest/task. Basically, it is the same reinforcement and remediation strategy used in edutainment but seamlessly built into the game with a more engaging and robust narrative. Star Wars Knights of the Old Republic and games similar to it are like being the star of a movie and you get to pick how the movie progresses. When combined with the other game characteristics, expressive choices contribute to provide an immersive experience. If the learner becomes truly immersed; hopefully that immersion will generate a level of motivation and effort ideal for higher order learning (Dickey, 2005).

Strategic choice. When the learner makes choices that affect the manner in which a game is played those decisions are strategic choices. Strategic choice refers to the gamer's ability to change some game attributes, such as level of difficulty, allotted time, and number of players. In edutainment, gamers usually select the level of difficulty prior to play, typically designated as Rookie, Veteran, and Expert. In Number Munchers, gamers can choose their grade level, third through eighth, and selecting a higher grade level will speed the game up. The gamer will have less time to select

correct answers. Choosing the level of difficulty is supposed to improve learner motivation because they will be given optimally challenging problems. In commercial games, the game can automatically progress the learner from easy to difficult content this is known as "leveling up." In Super Mario Brothers (Nintendo, 1994), the first level is fairly easy. Providing as easy level at the outset of a game allows the gamer to learn the interface, how to operate the controls, and how to play. The last level of the game is usually the most difficult and the gamer cannot get there until he or she has completed all previous levels. "Leveling up" can be designed into serious game to have learners gain prerequisite skills. For example, a hypothetical firefighter training serious game, the game would not start out on a difficult burning skyscraper level but lead up to that with levels that would facilitate learning the knowledge and skills for tackling a burning skyscraper. However, a serious game could have all levels of difficulty present at the outset.

Providing all the levels (easy to difficult) at the outset is probably setting the learner up for an experience where they learn by failing. This serious game design potentially could provide a powerful learning experience, but some type of coaching and or debriefing activity would need to be built into this learn by failure design. Debriefing is when the learner reflects on their performance with an instructor, and/or possibly other learners, to analyze their performance and generalize that performance to the real world. Debriefing can be accomplished outside the game, after the game, or be part of the game (Peters & Vissers, 2004). Debriefing can be oral communication and/or it can be written, through email, discussion board, or paper (Petranek, 2000). Debriefing could play a key role in assisting learners in understanding their errors so that they can correct or overcome them.

Coaching typically occurs while the game is in progress. Like debriefing, coaching could be oral or written and done by the instructor and/or other learners. Coaching could be a critical part in facilitating learning because coaching can be very prominent at the beginning of the game and scaled back as the learner progresses or needs to learn how to be autonomous (Acovelli & Gamble, 1997; Rieber, 1996). Both coaching and debriefing are valuable instructional strategies that can be integrated into serious games to support learning while retaining the authenticity of the game play because both strategies can be integrated into the game's story or context (Iuppa & Borst, 2007).

Tactical choice. Tactical choice refers to the gamer's ability to make decisions about how they play the game. How a gamer decides to do "x" instead of "a" in a given situation or context and whether the gamer is given access help or whether the gamer choose to access help are all tactical choices (Hannafin & Peck, 1988). Many edutainment games contain a main storyline or linear path from beginning to end. At times, the edutainment game may "branch" off of that main line to an alternative plot, to more difficult content, or go to remediation (Hannafin & Peck, 1988).

If Number Munchers was turned into a branching game, it could include a conditional branching mechanism where if the gamer were to get a predetermined number of correct answers the game would automatically increase in difficulty. Conversely, a conditional branch could be included where if a gamer got a predetermined number of incorrect answers the game would automatically shift to a remedial tutorial or ''loop'' back to easier problems. In many commercial and serious games, the same type of tactical choices exist; yet there are many more.

In Civilization, if the gamer has selected the Romans (expressive) for their military ability (strategic) because she wants to conquer the world (strategic), how she conducts warfare (tactical) is up to her. She could conduct warfare by stock piling weapons then attacking, she could attack early and without warning hoping to catch her opponents off guard, and so on. Whatever method she chooses will result in varying degrees of success. If a particular tactical choice was successful, typically the player will use that choice again until it results in undesirable results. However, this trial and error approach maybe an effective serious game design only if supported with integrated assistance.

In edutainment, assistance often comes from selecting the ''help'' button to access tutorials, frequently asked questions, or glossaries. Typically, these provided a review of the game play, rules, scoring, and so on. (Steinberg, 1990). Some serious games come with thicker user manuals, have tutorials that allow users to complete ''training stages'' that help learners learn how to play the game before advancing to the real game. Some serious games use NPCs as trainers or pedagogical agents. The NPCs as pedagogical agents can be used to deliver content, tasks, quests, or assist in moving the narrative along by divulging back story or information. The pedagogical agents can be used to ''push'' learning in by providing key information, assistance, coaching, or guidance. A variety of pedagogical agents could be tailored to help ''pull'' learning together by coaching learners to gain a level of understanding and/or manage a particular situation, problem, or project (Jacobs & Dempsey, 2007).

In some commercial games, the gamer controls a team of avatars. Typically, the gamer is in control of their avatar but can switch to and control another avatar. When the gamer is not in control of an avatar, the game takes control of it basically turning it into an NPC. Switching avatars allows the gamer to use the unique abilities of the other avatars. For example, in Star Wars Knights of the Old Republic the gamer can switch from her jedi, that is a master of the lightsaber, to another avatar jedi that is good at jedi powers, or switch to a third avatar jedi that has a special healing ability. In a serious game, shifting to different avatars can be used to provide learners with a more elaborate perspective of the situation or problem. The switching avatar design could be used in a firefighter training serious game where the trainee can switch from a firefighter battling the three-alarm inferno, to the firefighter operating the ladder truck, to the chief managing the squad. Using avatar switching would require the learner to learn a variety of skills and provide a broader, more detailed understanding of the processes and roles of a team. Many commercial online games expand on the avatar team design by incorporating other real players. Games such

as EverQuest and World of Warcraft allow the creation of teams of avatars by communicating with others using built-in instant messaging (IM).

Online games use in-game IM to ask for assistance, plan strategy, or just engage in conversation. In a serious game, the IM feature could be used to improve upon the prescribed dialogue and narrative by allowing real learners and instructors to collaborate, ask/receive assistance, deliver content, guidance, and coaching (Prensky, 2001). All the uses of conversation in a serious game are very similar to the roles instructors must fulfill in many constructivist learning methods that call for the instructor to provide scaffolding, resources, coaching, guidance, and assistance. This further supports the need for research assessing the integration of serious games with constructivist learning theories and methods.

Challenges

Challenges are the game's tasks and activities (Malone & Lepper, 1987). All edutainment, instructional computer games, commercial, and serious games provide learners with challenges (Dickey, 2005; Hannafin & Peck, 1988; Koster, 2005). In edutainment, learners typically must complete challenges to solve a problem or practice their learning. Usually the challenge is the instructional content (answer the math problem) and is why much edutainment are drill and practice activities sugarcoated with game characteristics. A typical edutainment design is a kin to the "carrot and stick" instructional method where the learner will complete a challenge and it is followed up with an entertaining aspect. In these "carrot and stick" edutainment games it is easy to distinguish the challenges (learning elements) from the fantasy elements. Like edutainment, the challenges in serious games should be designed to fulfill learning goals. Yet, in serious games the challenges are seamlessly integrated with the game—it is hard to distinguish the learning from the fun. By completing challenges, the gamer typically acquires skills that lead to more complex challenges and thus more opportunities to acquire more skills and knowledge (Gee, 2003). Unfortunately, we do not have a plethora of serious games to draw from to help clarify the change in the use of these characteristics. To make up for that deficit, I will use hypothetical examples to accentuate the change in the use of the challenge characteristic.

Reservoir operators: hypothetical serious game. To explain the challenge characteristic, I will describe a hypothetical serious game for training reservoir operators. The challenges in this game would involve learning the correct reservoir operating procedures and applying those procedures in a variety of settings (rural, urban) under a variety of circumstances (flood, severe storm). Once the reservoir trainee has completed a basic challenge such as operating a rural area reservoir under normal conditions, the trainee would level up to a more difficult challenge. The more difficult challenge would build on the prerequisite skills and facilitate learning new content through a new problem (drought conditions) and/or context (urban reservoir). On

successfully completing each challenge, the trainee would receive appropriate rewards and feedback. The feedback could be debriefing sessions, reflective activities, and evaluation from instructors targeted at assisting the learner in assessing their performance. These valuable instructional and assessment activities should be seamlessly integrated with the game. For example, the instructor could be "disguised" in the game as veteran reservoir operator or supervisor to further immerse the learner (Hotchkiss, McDonald, & Singley, 2006).

In many commercial games, gamers often do not perform adequately and fail to complete challenges. Often the consequence for failure is that the player loses one life, starts over from where he left off, and repeats the situation until success is achieved. In a serious game, failure could be a valuable learning experience because it would improve the authentic and immersive experience by providing realistic consequences. Failure could also allow learners to try new strategies and understand how they learn. For example, a learner that fails to correctly apply the correct reservoir procedures in a flood situation results in 10,000 deaths. The use of fake, but authentic, news footage and other media could show the learner the importance of the training and improve learner motivation. The learner may have failed because they attempted a procedure outside the training content. Thus, providing realistic and authentic consequences for failure may be a viable method for discouraging deviations from the standard operating procedures. Yet, if the deviation resulted in a favorable outcome the learner may have discovered a valuable strategy and new knowledge that may contribute to the development of different procedures in the real world, similar to Prensky's anecdote of the tank simulation. Turning each failure into a valuable learning situation could result in the learner reaching the learning goals because the learner would be made to practice the challenge until they got it right, much like the looping mechanism in edutainment. A serious game could include debriefing and discussion sessions, either in-game or face-to-face, that could provide appropriate remediation. Either option, or other possible options, could provide the optimal and most appropriate learning experience and feedback options. Many serious games provide unique goals, choices, and challenges that allow the gamer to interact with a complex content, yet this alone does not provide all the necessary events for learning (Squire, 2003). Providing reflective activities and other instructional supports can make the underlying simulation model visible. "Seeing" aspects of the serious game can facilitate learning (Alessi, 2000; Reigeluth & Schwartz, 1989). Guiding the gamer to organize and reflect on their understanding is as important as the serious game in facilitating knowledge acquisition and transfer (Moreno & Mayer, 2005; Paras & Bizzochi, 2005; Thatcher, 1990). Kolb's (1984) experiential learning model has reflective observation as an aspect that bridges the learner's understanding from concrete experience to abstract conceptualism. If games are viewed as an experience, reflection allows the learner to return to the experience, in this case the game, to gauge their, and possibly others', understanding of the experience, so that they can attend to the positive and negative occurrences of their game play, which allows them to

reevaluate the experience in a new perspective that facilitates knowledge acquisition (Thatcher, 1990).

Clearly, the authenticity of the role and context can make the design of challenges easier, especially when they closely match the workplace. Business simulations often take advantage of the similarities by designing training in a familiar work context, with similar clients, products, and so on (Aldrich, 2004; Crookall, 1987). Many business simulations could be redesigned into serious games by integrating the characteristics. Yet, when designing serious games for academic disciplines, the use of fantasy elements maybe important for crafting engaging and instructionally sound challenges (Iuppa & Borst, 2007). Academic subjects, such as history, calculus, or chemistry, do not have obvious roles or contexts, so fantasy elements are needed to create engaging challenges. Many constructivist learning methods may provide ideal frameworks for designing challenges. Such methods as open learning environments (Hannafin, Land, & Oliver, 1999), goal-based scenarios (Schank, Berman, & Macpherson, 1999), anchored instruction (Bransford & etal., 1990), situated cognition (Brown, Collins, & Duguid, 1989), problem-based learning (Savery & Duffy, 1995), and constructivist learning environments (Duffy, Lowyck, Jonassen, & Welch, 1993) require learners to solve problems, react to situations, craft solutions, and reflect on their experiences within a relevant context. Furthermore, some of these methods call for the use of narrative, like many commercial and serious games use, to provide an authentic context. Although these methods maybe excellent guides they should not be sugarcoated with game characteristics in a rash attempt to create a serious game. Instead, instructional designers and serious game designers should concentrate on designing challenges that meet the learning goals, sequencing the challenges to build upon prerequisite skills, crafting methods for learners to reflect, devising means for the instructional supports, finding appropriate ways to turn failure into learning, and seamlessly integrate game play and instruction.

Fantasy

Nearly every game contains fantasy elements in an attempt to provide motivating and exciting game play (Cruickshank & Telfer, 1980; Lepper & Malone, 1987; Parker & Lepper, 1992). Fantasy can be categorized as either exogenous or endogenous. Exogenous fantasy is used as reinforcement for correct behavior or response to a challenge. On completion of the challenge, the exogenous aspect is typically given as a reward. In Number Munchers, after the gamer has successfully completed a level, they receive a little more plot. Essentially, there is a disconnect between the challenge and the fantasy aspect (Malone & Lepper, 1987). This disconnect is the reason why edutainment is referred to as drill and practice activities disguised as games.

Endogenous aspects have little to no disconnect between the game and the learning; the game's fantasy aspects are not just a reward, but help develop the gamer's knowledge (Malone & Lepper, 1987). Most serious games would be classified as

endogenous fantasy; yet, many serious games may contain exogenous aspects, but these aspects are not the driving force of the game or the instruction (Habgood, Ainsworth, & Benford, 2005).

America's Army: Rise of the Soldier. In America's Army: Rise of the Soldier (Ubisoft, 2005) the gamer is rewarded with a new mission, new equipment, and so on for successfully completing a challenge. As the gamer improves their soldier avatar along a particular career path (i.e., sniper), they improve those specific skills by completing appropriate challenges and are rewarded accordingly. The rewards are inherently and authentically linked to the game, the learning, and provide the learner with positive reinforcement. Both exogenous and endogenous fantasy improve motivation and time on task, but because there is no disconnect between instruction and fantasy in endogenous fantasy, it may help in transferring learning to the "real world." Elements such as fidelity and context are two fantasy aspects (both exogenous and endogenous) that seek to improve motivation, time on task, offer reinforcement, and assist in learning transfer.

Fidelity. Fidelity is using graphics, audio, video, three-dimensional virtual worlds, and artificial intelligence to authentically represent reality. Providing true to life images, landscapes, sound, video, and dialogue can create an exciting and immersive context (Alessi & Trollip, 2001; Gredler, 2003). The degree of fidelity may be important for achieving the defined learning goals. If the learner needs to engage with exact replicas of devices or places (i.e., cockpit consoles, geographic locales, and historical places) a high degree of fidelity is essential because the authenticity will help transfer knowledge to the real world. Hence, if the learning goals do not define a need for authentic contexts, the learning goals can still be achieved with a lower degree of fidelity (Hannafin, Hannafin, Hooper, Rieber, & Kini, 1996; White, 1984). If authentic contexts are to be used there maybe a need for more complex interfaces to support and provide a greater number of abilities, skills, and actions (Gee, 2005; J. C. Herz, 1997; Prensky, 2001).

Doctor: hypothetical serious game. In a hypothetical serious game in which the gamer becomes a doctor, the gamer as doctor decides her areas of specialty and uses scalpels, X rays, and stethoscopes in context. In this context, patients arrive to the office and the gamer has to diagnose ailments, prescribe solutions, and administer treatments. The patients are NPCs and the gamer interacts with them through conversation that mimics real communication. To replicate conversation games use a bevy of "canned response" options that allow gamers to communicate with NPCs. Yet, instead of just reading the text on the screen, the NPCs will "speak" to the character complete with voice inflection, face, hand, and body gestures (Gee, 2003).

In this fictitious doctor training serious game, the interface would have to devote enough screen space for the learner to perform all the tasks required in the game challenges. There might be a patient interface, equipment interface, medical reference interface, interfaces for communication with nurses, doctors, pharmaceutical

reps, and so on, and controls (keyboard, joysticks, controller) that allow the gamer to manipulate each interface. Despite all this realism, learners will not learn everything they need to know from the serious game. Learners will not learn to use a scalpel by handling a virtual one using a joystick, nor learn perfect bedside manners by "talking" with NPCs. Yet, just as pilots learn some elements of flying in flight simulators, medical students can learn some aspects of being a practicing doctor from serious games. Pilots greatly benefits from flight simulators and other professionals can benefit from immersive, authentic, and instructionally sound serious games (Prensky, 2001).

Context. Fidelity is the virtual backdrop and mechanism for the game. Context is the setting, narrative, story, scenario, characters, back story, problem, and so on for the game play (Crawford, 2005; Dickey, 2006). Context, like fidelity, can enhance the game's authenticity. A well-written story with resounding characters and plot can enhance the authenticity just as excellent computer graphics can provide a very realistic backdrop.

In edutainment, the context is typically an initial mission or scenario with periodic snippets of the mission revealed after the completing a challenge. Typically edutainment is linear, screen-to-screen, branching games, where the gamer assumes a character and simply moves through a single plot line—a third-person perspective similar to books, television, and movies. The third-person perspective is the exact opposite of Gee's projective identity, where a gamer may develop empathy and pride for their avatar/entity. In a third-person perspective game, the learner acts more like a puppeteer (Gee, 2003). The third-person perspective is valuable instructionally because the learners maybe more apt to experiment with the characters, such as dolls or action figures, putting them into situations that they would not put *their* character into. In serious games, both third and first-person perspectives could be used and the linear branching story line, but, many commercial games and some serious games contain multiple plot lines that lead to a variety of different endings. Therefore, the gamer is not simply following along with the story but is crafting the narrative with their decisions and performance, which can create an authentic experience (Aldrich, 2005; Gee, 2005; Rollings & Adams, 2003).

Typically commercial and serious games that use multiple plot lines are coupled with an evolving game space that assists in making the ongoing stories and plot twists possible. The three-dimensional, evolving game space may allow learners to learn higher order thinking skills by encountering, observing, exploring, inquiring, investigating, participating, and solving problems (Gee, 2003; Gibbons & Fairweather, 1998). In these expansive game spaces, the game's goals, choices, and challenges require and encourage the gamer to explore and discover. Many games make use of "Easter Eggs," hidden treasures in the game, to motivate and entice the gamer to venture into all the nooks and crannies of the game space. Plus, serious games could provide information "just in time" or on demand to give learners up to the minute content and information. Providing dynamic content, such as

stock market prices, air traffic reports, water quality data, and so on, may improve transfer because learners were taught in an authentic context using real data and information.

Many role playing simulations and case-based instructional methods put learners into a story; the learner then has to make decisions and justify those decisions using the course content. The more authentic the story, the better the learner may transfer their knowledge back to the real world. Commercial games use story and context to disguise the underlying simulation model. If learners or gamers knew that the whole game was based on a probability algorithm, they would probably not be entertained or engaged (Rollings & Adams, 2003). Disguising the algorithms with context may improve the authenticity of the game and, hopefully, the learner's motivation. The use of context may help the learner identify real-world situations, where the content is useful and understand how to apply their learning accordingly (Iuppa & Borst, 2007; Koster, 2005). Exogenous and endogenous fantasy, fidelity, and context are important elements in serious games because they can make disguise underlying algorithms in instructionally sound and engaging means, convey authenticity, and assist learners in recognizing the relevance and complexity of content while facilitating their ability to transfer and generalize their understanding to the real world.

Conclusion

Serious game will not succeed just because they are games with educational content. Serious games are not going to be motivational "holy grails" despite each characteristic's motivational prowess. Furthermore, the computer programming and artificial intelligence required to produce a serious game should not be understated. The intention of this article was not to explain the complexity involved in programming the games mentioned, both real and hypothetical examples. However, the sophistication of the examples points to a need for instructional designers and the educational institutions where these professionals are developed, to understand artificial intelligence and the work of computer programmers to better articulate their ideas and assume a lead role in the development of serious games.

This article has identified some game characteristics in an attempt to explain the learning benefits of and inform the design of serious games. However, in identifying these characteristics, there is a possibility that it could contribute to serious game designs that are mere re-creations of commercial games with learning inserted; a similar unfortunate phenomenon that happened with edutainment. Yet, if the potential of serious games are to be realized game designers and instructional designers must bridge the gaps in their respective crafts by entering into a dialogue on the game characteristics—competition and goals, rules, challenges, choices, and fantasy. The identification of how these particular characteristics can facilitate learning is an attempt to establish a common vocabulary that can propel this discourse and meld the talents of game designers and instructional designers. Hopefully, the

discussion of game characteristics promotes a shared understanding of serious games and the talents that each profession can bring to reach the potential of serious games. Serious game designers should strive to combine the game characteristics with pedagogical elements, while keeping the fun and the learning in perfect balance. This balancing act is not formulaic; hence, much research is needed in identifying and explaining how motivational tenets, the principles of instruction design, and the many instructional theories, models, processes, and strategies should be integrated and used with game design in designing serious games. As such, Instructional Design and Technology programs should be striving to build the connections and partnerships with game designers and developers both in the academic community (computer science, engineering, and game programming programs) and outside the academic community by asserting and advocating for their inclusion in the design of serious games. Instructional design and technology programs should be developing expertise in the area of serious game design that can lead to the aforementioned connections because their expertise in learning, motivation, content architecture, and computer-mediated instruction are essential and extremely valuable pieces to include in the design and development of serious games because this expertise will enable the creation of serious games that achieve high level of learning and fulfill their potential.

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