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Using serious games in an educational setting

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Abstract

This literature review examines the use of digital games also known as serious games in a school setting to determine the benefits of games on preparing students for using 21st century skills. Studies on using serious games from the last 12 years were analyzed and evaluated. The review explores different genres of serious games. It examines benefits of serious games including social interaction, collaboration, and complex thinking skills, as well as their disadvantages The review also identifies game characteristics that support best practices in education. Serious games are a vital tool to teach students many skills needed for the future.

USING SERIOUS GAMES IN AN EDUCATIONAL SETTING

A Graduate Review

Submitted to the

Division of Instructional Technology

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Of the Requirements for the Degree

Master of Arts

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by

Angela Webb

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ABSTRACT

This literature review examines the use of digital games also known as serious games in a school setting to determine the benefits of games on preparing students for using 21st century skills. Studies on using serious games from the last 12 years were analyzed and evaluated. The review explores different genres of serious games. It examines benefits of serious games including social interaction, collaboration, and complex thinking skills as well as its disadvantages The review also identifies game characteristics that support best practices in education. Serious games are a vital tool to teach students many skills needed for the future.

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INTRODUCTION

Children are surrounded by digital games that are engaging and motivating. Children play these games in their homes or with friends. Many adults, including educators, don't understand the benefits of these games or what it is about digital games that children find so engaging and motivating. This failure to understand prevents educators from accessing a form of learning that can be both effective and appealing to the students. This review is important because educators need to be aware of serious games. Serious games are digital games with learning outcomes. Educators need to know the advantages and disadvantages to using serious games.

Education must to be motivating to the students. Students need education that prepares them to be competitive in a global society. Digital games require many of the skills needed for the 21st century such as critical thinking, collaboration, creativity, communication, and technology literacy. Prensky (2006) states, "Kids learn more positive, useful things for their future from their video games than they learn in school" (p. 4). Students learn better when they are motivated. Learning requires effort and effort will not be made without motivation (Prensky, 2006).

 The structure of education can change as a result of the opportunities which technology can avail. This paper will specifically look at the use of serious games in a K-12 educational setting. The purpose of this paper is to examine literature about the use of digital games including learning outcomes and educational practices that are supported by serious games.

This review will investigate the following research questions:

1) What is serious gaming, and what types of different serious games are

available?

2) In educating students, what are the benefits and learning outcomes of serious games?

3) What are the disadvantages of serious games in educating students?

4) How can educators use the characteristics of games to support best practices in education?

5) What factors should be considered when choosing serious games to be used in the classroom?

METHODOLOGY

Many methods were used to find resources for this review. Databases used to search for educational journals included *ERIC, Academic OneFile*, and *Academic Full Text*. Google Scholar was also searched to find peer reviewed journal articles. In addition to locating journal articles, several books were also sought. These books were found through recommendations and references in other works. Websites related to the topic of serious games were also wanted. Many of these websites referenced articles and books that were also used in this review.

The reviewer used a variety of descriptors to locate resources. Descriptors used were *serious games, digital games, educational gaming, and game-based learning*. Phrases were also used to locate resources. These phrases included *effects of video games, negatives of video games*, and different categories of games (e.g., *augmented reality, massive multiplayer online*). Authors' names were also used to search for resources. Authors used were considered experts in their field and referenced one another in their sources. Authors searched for this paper included Kurt Squire, Marc Prensky, and James Gee.

The reviewer used several criteria to analyze the sources found. Whenever possible, the reviewer used peer-reviewed sources. The reviewer also considered the age of the sources. Sources from 2000 and later were used. Research on serious gaming has mainly been acquired since 2000. Video game research is older and was only used to supplement research on serious games. Older material was used only when it was considered foundational in thoughts and referenced by other sources. Another criteria used to analyze sources found on Google Scholar was to look the number of times the source was cited in other works. The more important resources had a higher number of citings.

The information from the sources was then evaluated before being included in this review paper. The content of the sources were evaluated for relevance to this review and accuracy of the material.

ANALYSIS AND DISCUSSION

The resources reviewed provided the researcher with a definition of serous games and categories of serious games. Resources also identified potential benefits, learning outcomes, and disadvantages of using serious games. Characteristics of serious games that support educational best practices were also found in the research. Lastly, the analysis will define factors to consider when considering using serious games.

Serious Gaming Defined

There are many synonyms used for serious games: digital games, educational gaming, and game-based learning. As mentioned earlier, in general, "most agree on a core meaning that serious games are (digital) games used for purposes other than mere entertainment" (Susi, Johannesson, & Backlund, 2007, p. 1). Serious games are designed with learning outcomes. Serious games are games that, "support, reinforce and accelerate the learning process, and support higher-order cognitive development" (Hong, Cheng, Hwang, Lee, & Chang, 2009, p. 424).

These games can be commercialized games designed for entertainment purposes, but positive learning outcomes have been identified for the children playing the games. Zyda (2005) observes that serious games are "more than just story, art, and software. They involve pedagogy: activities that educate or instruct, thereby imparting knowledge or skill" (p. 26). Zyda (2005) goes on to state that games use "collateral learning- the learning that happens by some mechanism other than formal teaching" (p. 27). Serious games "use entertainment principles, creativity, and technology to build games that carry out serious purposes (Rankin &Vargas, 2008, p.3).

The main goal of serious games is not entertainment, although entertainment is an element of serious games. Serious games are different from "edutainment." Edutainment games are designed specifically for educational purposes, and they have been around for many years. Parents are often drawn to them. These games are often, "essentially engaging tutorials that cover a particular topic in age-appropriate depth" (Johnson, Smith, Levine, & Haywood, 2010, p. 18). These include games that focus on a specific educational content like *Math Blaster* and *Jump Start* (Johnson, Smith, Levine, & Haywood, 2010). However, they are often tedious for children to do (Prensky, 2006,). Edutainment games are not always appealing to students because they all don't include an intriguing story. For a game to be appealing to students, it must combine instruction with a story (Zyda, 2005).

Categorizing Games

There are various ways to categorize games. The type of categorization used by individuals depends on the specific game elements that are being examined. Sawyer and Smith (2008) suggest that games can be categorized by the number of players and by game genre.

Number of Players

One can categorize the games based on the number of players. Multi-player opponent games involve 1-4 players at a time. Multiplayer tournament games are for 8-64 users. The massively multiplayer game can involve as many as 1000 players.

Genre

Games can also be categorized by the type of game play they use. This is classification based on genre. As games become more complex, they incorporate several genres into one game. Common genres include sports, action, strategy, role playing, driving,

adventure, puzzles, simulations, and alternate reality. Like genres of books, players often have a favorite genre of games.

Simulation

One genre used most often in military training is simulation games. Simulation games are also some of the first games used in education. Simulation games allow players to manipulate systems and see the resulting consequences, view events in new perspectives, and create hypothetical questions and test their hypotheses. This is done in a relatively safe environment. Often the game world closely resembles a real environment the player lives and works in. Simulations allow for the training of different scenarios for professionals. Simulations are used by the military, firefighters, and health care professionals (Rankin & Vargas, 2008). Their benefits are easily recognizable. Squire (2003) defines simulations as games that "model physical systems or social systems through another symbol system, such as a computer interface" (p. 4).

Simulation games are interactive. Each choice by the player affects the game and the player makes a new choice based on the previous one(Shaffer, 2006). Simulation games have goals or challenges for players to choose from, but they are often more exploratory. *Civilization* is a simulation game, "where players rule over a growing empire from hamlet, to city-state, to global dominion" (Shaffer, 2006, p. 6). In *Civilization*, players make decisions concerning their civilization. Their choices determine how their civilization grows or fails to thrive. *Civilization* is a game that teaches historical concepts and requires students to "critically evaluate and deconstruct historical representations found in popular culture" (Whelchel, 2007).

A study of 12 high school students enrolled in a United States History class examined the use of *Civilization* as part of the curriculum. The 12 students played *Civilization* as a whole class. The game was displayed on a smart board. Students took turns controlling the game; however classmates offered suggestions and recommendations. The game was played weekly for nine weeks, during that time data was collected through observations, teacher and student interviews, teacher and student observational journals, and a log of game play. The researchers then reviewed the data for common themes. They concluded that anecdotal notes suggest development of factual knowledge. "For example, students were able to define embassy" (Lee & Probert, 2010 p. 23).

One simulation game, *Supercharged!* was designed for educational use in the field of electromagnetism. A study conducted on the game split a middle school class into two groups. The control group learned electromagnetism through more traditional teaching methods such as lecture, observations, and teacher demonstrations. The second group played the game, received handouts, and lectures. The control group improved pre-test to post-test scores by 15%. The group that played the game improved their test scores by 28%(Squire, Barnett, Grant, & Higginbotham, 2004).

Role-playing games

Role-playing games (RPG) are games where the player takes on a character in the game. The player takes on the characteristics and traits of the character. *EverQuest* is a role-playing game. Players create their character and their characters' personality traits. The character is called an avatar. Players carry out different quests and challenges in the game. While attempting the quests, players gain ability points for their characters

One study looked at the effect of using *EverQuest* in language acquisition. The study used 12 participants who were learning English as a second language at a liberal arts college. The participants were divided into to experiment groups. The first group played EverQuest alone while Group 2 played in teams of four. Each team of four included two English as second language students and two non-English as second language students. After playing the game a post-test was given to determine the students' acquisition of new vocabulary words. The first group had an average post-test score of 55.56 out of 100 points. The group that played as a team had an average post-test score of 82.22 out of 100 points. The researchers Rankin, McNeal, Shute, & Gooch (2008) found that the game "shows great promise as a second language pedagogical tool." (p. 47).

Massively multiplayer online role playing games

Massively multiplayer online games (MMORPG) "bring many players together to work on activities that require collaborative problem-solving" (Johnson, Smith, Levine, & Haywood, 2010, p. 18). MMORPGs are online role-playing video games that allow players to interact with other players and with the game. Often, players have goals to meet either individually or with the help of other players (Steinkuehler, 2004).

World of Warcraft is a popular MMORPG. The game is set in a world known as Azeroth. Two groups are struggling for power. The player will choose and create a character which determines which side of the struggle the player will play for. The player's character is given quests (or challenges) to fulfill. Succeeding at these quests will grow the player's character with new skills and abilities. World of Warcraft even allows players to have more than one character to play with in the game ("What is world," n.d.). This allows the game to be experienced differently. While playing the game, players will need to work

with others to complete more complicated and demanding quests. They often need to find a player with a character with different skills and abilities from their own character ("What is world," n.d.).

When collaborating in teams, players combine their sets of skills and knowledge to be successful. This sharing and collaborating of knowledge and skills can be done in the game and on various Internet sites. Discussion groups and message boards are a tool used by players to communicate hints, tips, and develop strategies (Gee, 2003).

Alternate Reality

Alternate reality games (ARG) are "open-ended, collaborative games in which players find clues and solve puzzles in experiences that blur the boundary between the game and real life" (Johnson, Smith, Levine, & Haywood, 2010, p. 19). Recent examples of ARG with a specific educational component include *World Without Oil* and *Superstruct* (Johnson, Smith, Levine, & Haywood, 2010). The games deal with real-world current events. .

In an ARG, players start by finding an entrance or starting point into the game. This entrance is known as a rabbit hole. "Rabbit holes are generally things that link the player to a website or bring them to some sort of installment in the real world specifically made for the game"(Berg, Brown, & Pastorello, 2010). One popular ARG, *I Love Bees* started with two rabbit holes. One was a FedEx package sent to about 20 known online digital games. The second rabbit hole was a flash of a website in a trailer for an upcoming popular video game. Both rabbit holes led players to the website (Kim, Allen, & Lee, 2008). Once at the website players were given no rules or objectives, "Instead, the players had only a call to action, a very complex data set, a few seemingly random threads of story- and the freedom to respond to them however they wanted" (McGonigal, 2007, p. 9).

"World Without Oil" (WWO) included over 1900 players for 32 weeks in 2007. Players were asked to imagine a world where the demand for oil was greater than the oil supply. Players were then tasked with finding solutions to the problem. "Some planted gardens, others biked to work: some bought hybrid vehicles, others embraced biodiesel" (Chang, 2009, p. 4). The theme of WWO was "play it-before you live it." Rusnak, Dobson, & Baskic (2008) studied artifacts from 40 WWO players. The artifacts they examined were available online and included blogs, videos, and emails. By examining the artifacts they found that 83% of their sample developed a greater awareness of alternate energy. 63% "translated their increased understanding of how to live in ecologically sustainable ways into real-life action" (p. 387).

These games ask players to, "Investigate, weigh evidence, compare notes, test hypothesis, and synthesize information as they draw conclusions about what has occurred and why" (Squire & Jenkins, 2003, p. 24). Alternate reality games allow players to use handheld devices such as cell phones, desktop computers, and fax machines. "These networked platforms enabled individuals to instantly update the entire player base with founded data and novel interpretations" (McGonigal, 2007, p.12). .

In *Environmental Detectives,* (another ARG), players work in teams. The teams are asked to investigate a chemical spill on a college campus. Players are allowed to talk to virtual experts, research the science behind the problem, and collect data on the spill. Students use a handheld computer that allows them to take ground samples. At the end, the teams must present their findings to a college president within the game. As a team, players must decide what data collection is needed and how to collect and present their data. They work under a time frame, making collaboration a key (Squire & Jenkins, 2003).

Jeffrey, Lee, Thomas, & Dombrowski analyzed five ARGs from 2001-2009. The ARGs were compared to find common characteristics of the games. Those analyzed included *The Beast, I Love Bees, Last Call Poker, Year Zero,* and *Free Fall.* This case study found that all five ARGs "emphasize collective problem solving, when a group works together to solve a problem faster and more completely than an individual" (Jeffrey, Lee, Thomas, & Dombrowski, 2009, p. 4).

<div align="center">Benefits and Learning Outcomes of Serious Games</div>

Serious games can have many positive benefits for the children playing them. Serious games allow students to think in ways that are different and more complex than they are asked to think in education (Prensky, 2006). Serious games develop 21st century skills that are essential for students to learn. "The most important challenge the U.S. education system faces is…fostering 21st century skills and knowledge in learners so that they are prepared to participate in our global, knowledge-based civilization" (Dede, 2004, p.12). The Partnership for 21st Century Skills (2009) has identified four learning and innovation skills needed for the 21st century: critical thinking and problem solving, communication, collaboration, and creativity and innovation. These skills can be found in serious games.

<div align="center">*Critical Thinking and Problem Solving*</div>

Playing video games also helps students with decision making. Often in games, the player has to "assess risks and consequences and make decisions in a hypothetical yet realistic situation" (Dorman, 1997, p. 135). The game, *SimCity,* has players build a city of their own. The goal is to create a thriving city. Players make decisions about zoning and where to place key city components such as a power plant and junkyard. The decisions made

by the player affect the growth of the city. This kind of decision making allows players to see the results of their decisions (Squire, 2003).

Making decisions gives students a sense of power (Prensky, 2006). Games allow players to guide their own way. They get to experiment through trial and error. By manipulating a system, the player can see the direct consequences and make decisions based on those consequences (Sandford & Williamson, 2005).

Communication

Children can develop socialization skills through their video games. They create an identity to share with the world, not based on their looks, but based on their online work. This allows students to build a deeper understanding of their identities and how to interact with others.

These games are often not played in isolation. Rather, students congregate together, teach novices how to play, and discuss their games. Students communicate with other players during the game through typed chat, and voice chat (Mansour S. & El-Said, 2008). When choosing games to play, students often ask opinions and discuss games with other students. These discussions are often in-depth analyses of the games and what makes them good or bad. Students also help each other advance through levels they are struggling with. "In many cases, games actually lead to more social interaction" (Prensky, 2006, p. 83). Students make friends through their games and communicate through chat rooms, message boards, and email outside of the game. The discussions will lead to non-game subjects as students build online friendships. Seay, A.F., Jerome, W.J., Lee, K.S., & Kraut, R.E. (2004), created a multiple choice survey. There were 1836 respondents aged 12 to 68. The study

determined 53% of out-of game communication is used for social exchanges not pertaining to the game. This shows student interaction other than purely gaming interactions.

A study of 20 college students enrolled in a British Literature class examined the social interaction of multi-player serious games. The study created a game called "*The Village of Belknap.*" Students were placed in a face-to-face interaction section or online only section that played the game. After the course, students were asked to complete "The Relational Communication Questionnaire."The questionnaire contained 19 items on a five-point Likert scale examining perceived social interaction. The study found there was "no significant difference between perception of social interaction of students who were enrolled in the online section and the students who were enrolled in the face-to-face section" (Mansour & El-Said, 2008, p. 776). The study shows that interactions online are perceptually the same as face-to-face.

Collaboration

Several large commercialized games have been successful in building player collaboration. Some games cannot be mastered without the help of others. Players must rely on the skills of the other players added to their own skills to be successful in the game (Squire, 2003). *Toontown* (www.toontown.com) is a game that requires collaboration to win. In *Toontown,* players need to defeat "Cogs" which are "machine-based members of the evil gang that wants to take over the town" (Prensky, 2006, p. 106). There are low-level Cogs that can be defeated alone. There are also higher-level Cogs that are much more challenging to defeat and will require a group of players to defeat. The only way students can accomplish this is, "by learning to cooperate well with real people in real time" (Prensky, 2006, p. 108). Players also share tips and hints with other players. They help inexperienced players and

offer advice. In *Toontown,* when an experienced player helps a newer player, both are rewarded in the game (Prensky, 2006). Collaboration of this type is known as distributed knowledge.

In serious games, knowledge is networked through distributed learning. This allows for players to become better than their potential because they combine skills and knowledge as they collaborate with other players. Players must also learn how to leverage the knowledge of other players to their benefit (Gee, 2007).

One study examined collaboration using three games; *Evolution, BuinZoo,* and *Museum.* The subjects of the study were from ten eighth-grade science classes. The classes were from five different schools. One class from each school was given traditional learning as well as a mobile serious games (MSGs) and activities that contributed to the serious games. The control group was taught through traditional learning. Both classes had the same instructor. The subjects were given a 25-item Likert "scale for the perception of collaborative work" (Sanchez & Olivares, 2011, p. 1945.). The Cronbach's Alpha reliability index for the collaborative scale was 0.82.

"The results show that the methodology developed through the use of MSGs contributes to the development of collaboration skills." The study also showed that students in the experimental group, "express a better global perception of their collaboration skills" (p. 1950) than those in the control group.

Creativity

Students learn to think innovatively and creatively through their game play (Shaffer, 2006). Game players can go even further by creating their own versions of the game or changing the game, called modding. "Many popular game engines come with scripting

languages that allow users to modify their behaviors, create new worlds for exploration, or even modify existing games into completely new ones"(El-Nasr & Smith, 2006, p.7). Modding requires many skills "ranging from programming to graphic editing, storytelling, video making, sound recording, summarizing, conversation writing, and scripting" (Loh & Byun, 2009 p. 410). As the players become more advanced at modding, they can even create new games. Some of the new mod games have been bought to be played by others (Prensky, 2006). This creativity encourages the game players to take risks, make decisions, and apply skills they currently have. Creativity is a skill that is needed by adults today in our society.

A study by El-Nasr & Smith (2006) evaluated two different high school classroom settings and projects where modding was used. Each class was assigned a project that involved modding a game. The first class was given the game *WarCraft III* engine. "The game engine is composed of several editors: the world or map editor, trigger editor, character editor, etc" (El-Nasr. & Smith, 2006, p. 11). Students used the editors to create new games such as a variation on Tetris and football. The second class observed was more familiar with computer programming. They were given two different projects to complete. The first project had students working in groups of 5 to create a 3-D environment using the engine *WebDriver*. The class also had to create a new level to the game *Unreal Tournament Exercise*.

The study found that students needed to know conceptual knowledge such as 3D geometry and vector math and learned these concepts through modding. By modding the game with the set rules of the project, students encountered problems that required understanding of conceptual knowledge. Students used their conceptual knowledge from class to complete their modding projects. This was especially found in the class where

students were instructed to create 3-D environments and characters to interact in those environments. The study also found that "during the design process, skills such as analysis, synthesis, evaluation, and revision must be used, providing opportunities for learning content and metacognitive skills such as planning and monitoring" (El-Nasr. & Smith, 2006, p. 9).

<div style="text-align:center">Disadvantages of Games</div>

As students engage in more game play, they are exposed to potential dangers. Being aware of potential dangers is important. Adults need to be able to make informed decisions about games. This can help gaming experiences become safer for students (Hong, Cheng, Hwang, Lee, & Chang (2009). These disadvantages are important to understand so that steps can be taken to minimize the potential risks.

It is also important to realize that, "playing games does not appeal to everyone" (Squire, 2005, p. 8). Therefore, serious games should not be the only mode of education. When used in education, the purpose for using serious games will need to be explained to students as Squire determined that not all students knew how a game could help them learn. Some of the potential disadvantages often associated with games include a sedentary lifestyle that leads to obesity, aggressive behavior, and physical harm.

<div style="text-align:center">*Sedentary Lifestyle*</div>

There has been concern with the use of video games and the increase in childhood obesity. The hypothesis states the increase of childhood obesity is due to the time a child spends playing the video game. The more a child plays a video game, the less time that is spent on physical activities (Vandewater, Shim, & Caplovitz, 2004; Center for the Advancement of Health, 2004).

In a study conducted using 2831 participants aged 1-12 years old, it was found that the amount of time spent on a video game held a positive linear relationship with the weight status of a child. The relationship was even stronger in younger children; below eight years old. The researchers were unable to determine the casual direction of the relationship. It is possible that heavier children play more video games because they are heavier. It is also just as likely that playing more video games increases a child's weight due to being sedentary (Vandewater, Shim, & Caplovitz, 2004).

Children often play a video game for longer than anticipated or planned periods of time. In a survey of 11-16 year olds, "60.6% reported playing longer than intended" (Phillips, Rolls, Rouse, & Griffiths, 1995, p. 688). Based upon a self-report survey, Phillips, Rolls, Rouse, & Griffiths (1995) found that these children played more than six times per week, played longer than an hour each session, played longer than intended, and neglected their homework to play. This also leads to the children having a more sedentary lifestyle.

Aggressive Behavior

There have been many studies on the effects of watching violent and aggressive television along with playing violent and aggressive video games in children. These studies are conflicting and not conclusive. The link between aggression and media is not a recent hypothesis. A study conducted by Bandura, Ross, & Ross (1963) showed "that children readily imitated aggressive behavior exhibited by a model" (p. 3). The experiment exposed children to aggressive acts through real life models, humans on film, and cartoons on film. The children were then observed to see if they exhibited any of the same aggressions. These three groups were then compared to a control group. The experiment confirmed "the prediction that exposure of subjects to aggressive models increases the probability that

subjects will respond aggressively when instigated on later occasions" (Bandura, Ross, & Ross, 1963 p. 7). Another study found a link between violent video games and aggression for as long as 24 hours after ceasing to play the violent game (Bushman & Gibson, 2011). These results enhance the general arousal theory.

General arousal theory "implies that children when aroused most likely will behave in a manner most recently observed" (Dorman, 1997, p. 134). This theory suggests that after playing a game that exhibits aggressive behaviors, children will be led to exhibit similar game behaviors.

According to another theory, social learning theory, "violent video games allow children to practice aggressive behavior and to be rewarded for successful aggressive behavior" (Kirsh, 1998, p. 177). In his study, Kirsh (1998) found that playing violent video games led children to see the world in a negative way. Kirsch had subjects play either a violent or a non-violent video game for five minutes. After the game, subjects were read a story where the main character caused a negative event to occur. The subjects were then asked about the motives of the characters' action. Those that had engaged in the violent video game perceived the motives to be more negative than the subjects of the non-violent video game.

Ferguson (2007) did a meta-analysis of current data and studies on aggression in video game players. Ferguson's result "did not support a relationship between violent video game playing and aggressive behavior" (p. 313). Ferguson (2007) did conclude that there may be more risk for violent behavior from games for special populations.

Anderson and Bushman (2001) also conducted a meta-analysis of data and studies on aggression and video game players. They reviewed 35 research reports with 4,262

participants. Anderson and Bushman (2001) found that "high video-game violence was definitely associated with heightened aggression" (p. 357). Increased aggression occurred in all ages and sexes.

Gender Bias

Gender preferences and stereotypes for those preferences have long been debated. Generally speaking, "girls usually play more with dolls, tea and kitchen sets, dressing-ups, while boys prefer construction and transportation toys" (Servin, Bohlin, & Berlin, 1999 p. 43). In a study conducted by Servin, Bohlin, & Berlin (1999) they observed children playing with predetermined toys that included toys considered feminine, masculine, and gender neutral. The results of this study showed that as young as the age of 1, children preferred same-sex gender toys.

There is also some concern about males dominating game playing and the gender bias that results. "Video games are said to reflect gender stereotypes that favor masculinity" (Rosa et al, 2003, p. 76). Games often favor boys' preferences (Verbick, 2002). Also common in video games is the depiction of women as a victim and not as the main character (Gee, 2007).

Physical Harm

Video game play has shown some negative physical conditions in the players. These physical conditions are often treatable or preventable. However, they do exist and are a concern.

Playing video games can increase a player's heart rate and blood pressure. This is a result of stress and anxiety from playing the games (Dorman, 1997). A study by Murphy, Alpert, Moes, & Somes (1986) of 213 children ranging in ages 6-18 studied the effect of

cardiovascular reactivity and video games. The researchers measured the children's heart rate and blood pressure as they played a video game and were given three challenges in the video game. The study found the "video game evoked significant cardio vascular reactivity"(p. 1078). The average heart rate of the child increased 1.71 ± 0.64 beats per minute for the first challenge.

Additionally, video games have been known to produce seizures in some players. A seizure as a result of a video game is called, "Dark Warrior epilepsy." "Video games may provoke a seizure response more easily than television because video games usually consist of geometric figures and they are played with the participant sitting closer to the screen" (Dorman, 1997, p.133).

A third physical condition resulting from video game playing is known as "Nintendinitis." Nintendinitis is pain in the tendon of the thumb that results from too much playing at one time. It is from repetitious movements while game playing. This is easily treated and not a permanent condition (Dorman, 1997).

Gaming Characteristics that Support Best Practices in Education

"Recent studies suggest that when young people are playing computer and video games they are engaged in learning activities that are more complex and challenging than most of their formal school tasks" (Sandford & Williamson, 2005, p.3). Games use many of the same educational practices that have been found to be effective. By examining the actions in games that motivate and teach students, we can attempt to incorporate the same educational best practices. These best practices that are used in games include setting goals, providing feedback, knowledge of improving, flow, differentiation, situated cognition, reflection, motivation, and seven habits.

Setting Goals

Marzano, Pickering, & Pollock (2001) have identified nine educational strategies for increasing student achievement. Setting goals is one of the nine strategies. It was shown to have provided an average percentile gain of 18.

Gamers have to accomplish game goals and set their own. Setting a goal requires knowledge of one's ability and an understanding of what can be accomplished. "Goals we set for ourselves are the ones we are most motivated to reach" (Prensky, 2005, p.9).

Gamers have clear goals to achieve. These goals are short term and long term. Serious games also allow players to set goals for themselves. Goal setting is a complex thinking skill (Marzano, Pickering, & Pollock, 2001; Prensky, 2005)

Providing Feedback

Games provide players with immediate feedback both from the game system and often from other participants. Players gain skill as they succeed and fail within the game. Failure in the game is also feedback (Steinkuehler, 2004). Games provide players information needed in the game at the time it is needed. Video games provide this information immediately and it serves as feedback. "*System Shock*, for instance, spreads, throughout the game, the sort of information typically found in a manual" (Gee, 2003, p. 22).

Feedback in education leads to increased student achievement. Marzano, Pickering, & Pollock (2001) have provided generalizations on feedback to enhance educational practices. They suggest that feedback is more effective when it is timely. "Asking students to keep working on a task until they succeed appears to enhance achievement" (p. 96).

Flow

Videogames are at a level that can be challenging for the player, but doable. This allows the player to feel both pleasure and frustration. These levels were designed to challenge the player and then advance and become harder as the player gains expertise (Gee, 2007). "We learn best when working on things that are neither too easy nor too hard- a psychological state that researcher Mihaly Csiksezentmihalyi describes as *flow*," (Shaffer, 2006, p. 125). According to Csikszenthmihalyi (1990) the flow channel is between anxiety and boredom. When a participant enters the anxiety level, they need to increase skills to get back into the flow. To get back to flow from boredom, the participant needs to set a more difficult goal. "We grow either bored or frustrated; and then the desire to enjoy ourselves again pushes us to stretch our skills, or to discover new opportunities for using them" (p. 75).

Csikszenthmihayli (1990) identified eight components of enjoyable activities that often resulted in flow:

- the player must have a chance of completing the tasks

- concentration on the game

- clear goals

- provide immediate feedback

- the player must attend to the game so that worries from outside the game are eliminated

- the player must have some self control over their choices

- "concern for the self disappears, yet paradoxically the sense of self emerges stronger after the flow experience is over" (p. 49)

- removal of sense of time or duration.

In schools we need to apply this principle by challenging students and allowing them to feel the joy and excitement when they achieve the seemingly impossible. Difficult games make them engaging. For example, *Civilization* is a game that is engaging because of its difficulty along with, "complexity, flexibility, and replayability" (Squire, 2005, p. 8). The next step for teachers is to expand and challenge the students' previous success by giving an even harder challenge.

Adaptive/ Differentiation

Students playing games can have a wide range of abilities. Games are adaptive to fit the ability of the player. This makes the game more challenging for advanced players and gives extra help for players needing the help (Prensky, 2006). Games present players with complex problems. Games are "pleasantly frustrating," (Gee, 2003, p. 22). This sense of the game being just beyond the player's reach of expertise is motivating for the player.

Schools also need to be adaptive to a learner's levels of need. This is widely known in education as differentiation. It is a principle that has been used by game designers for years. Games allow players to customize the game to their level of play and ability. *Rise of the Nation* has players take skill tests that help players find the right level of game play that is challenging, but not impossible. As players become better at the game, they can adjust the game to match their new level of competence (Gee, 2003).

Situated Cognition

Situated cognition or situated learning theory is a learning theory where knowledge is integrated with doing. "That is, one learns a subject matter by doing what experts in the subject matter do" (Driscoll, 2007, p. 38). Serious games use this principle as players learn in their micro worlds and apply that knowledge to go further in the game. This learning is

more effective than learning that occurs outside the needed context (Driscoll, 2007).

Educators need to find ways to use the principle of situated cognition to make learning more

relevant (Van Eck, 2006).

Forty-five fourth grade students participated in a study that evaluated the effects of

situated cognition versus conventional instruction. The students were split into two groups,

those who learned map skills through situated cognition and those who learned map skills

through conventional instruction. The two groups were similar in standardized reading and

math test scores. The two groups took a 20-question pre-test before have their learning

experience. After the learning experience, students completed two post assessments. The

first post assessment was a 24-question written test. The second part of the post assessment

was a performance test of 33 items. The 33 items were each graded on a scale of 0-4. This

was called the Immediate Performance Assessment. These two post assessments were again

completed five months after the initial learning (Delayed Performance Assessment.) The

study found "that the two groups did not differ significantly on the immediate performance

assessment, but we found statistically significant differences between the groups on the

delayed performance assessment" (Griffin & Griffin, 1996, p. 300).

Reflection

When playing a challenging game, a player will often fail at the same task or goal

repeatedly, until she can pass that challenge. She does this by reflecting on what mistakes

she made, and how she could do better. This helps students learn, "innovative thinking by

reflecting on success and failures and the reasons for them," (Shaffer, 2006, p. 103). This

process of reflecting when one is stuck on a problem is used by highly successful

professionals. It is a skill that students must learn.

Educators need to incorporate more reflection into education. Students need to learn to express their ideas, opinions, and decisions. This will help them grow and advance to more challenges.

Motivation

Motivation is an important element in education as well as a key factor of serious games. People are "motivated to the extent that their behavior is expected to lead to desired outcomes " (Hong, Cheng, Hwang, Lee, & Chang, 2009, p. 426). Understanding motivation and what leads students to be motivated can be a powerful educational tool.

Keller's (1987a, 1987b, 1987c) ARCS model identifies four motivational categories: attention, relevance, confidence, and satisfaction. The first category is attention. Gamers must have their attention directed at a game in order to be successful. The second category is relevance. Gamers realize that completing a challenge or level is important to achieving an even larger goal. The third category is confidence. When playing a game, the player should be aware that the challenge or level is achievable with their current level of skill. The last category of motivation is satisfaction. Satisfaction occurs throughout games. The player feels accomplished when completing a level or challenge. The player also gains skill while playing and that serves as satisfaction as well (Keller, 1987a, 1987b, 1987c)

Playing a video game can also lead students to be motivated about a new topic. "Civilization players encounter history not as a grand narrative but as the product of several dynamic interrelated forces" (Squire & Jenkins, 2003, p.14). While exploring this simulation game, players ask "what if" questions. This may lead them to further reading or discussion about historical events (Squire & Jenkins, 203).

Seven Habits

Prensky (2004) identifies seven habits that can be gained from playing video games. Prensky based these seven habits on Steven Covey's popular book, *The Seven Habits of Highly Effective People.*

Prensky (2004) identifies three individual habits. The first habit is being *proactive.* Game playing allows players to make decisions. "You don't beat a game by waiting around for things to happen to you" (Prensky, 2004, p. 2). The second habit is having a *clear goal in mind from the beginning.* Good games continually have short and long term goals or objectives for players to accomplish. Players know these objectives at all times. The third habit is being able to *think about long-term objectives while working on the immediate objectives.* Both the immediate and the long-term goals have to be managed at the same time.

There are also three group habits that can be acquired by playing serious games. The first is *thinking in terms of your team* and how to accomplish the player's own goal and that of the team. The second habit is *communication* between team members. The last group habit is the ability to *use other player's strengths* in a combined effort to reach a goal (Prensky, 2004).

The last habit is the ability to *continually improve* one's skills. This continual improvement happens in games through more advanced levels of difficulty and by add-ons or sequels to games (Prensky, 2004).

Factors to Consider when Choosing Serious Games to be used in the Classroom

Serious games can become a part of education. "When embedded in the curriculum, they offer a path into the material that allows the student to learn how to learn along with

mastering, and truly owning, the subject matter" (Johnson, Smith, Levine, & Haywood, 2010, p. 18). Serious games can be used for many subject areas and for a wide age range. How to integrate serious games has been a concern of many educators.

Incorporating Games

Educators have three ways they can incorporate serious games into students' education. The first way is to have students build games from scratch. This incorporates many of the learning principles previously discussed by the reviewer. Students become designers and must make decisions about what the theme of their game will be. Students also have to problem solvers as their game develops. However, this can be very time consuming and difficult if the students do not have a knowledgeable leader or know how to design games (Van Eck, 2006).

A second way to incorporate serious games into education is to have educators and game developers work together to build games with learning theory and good game play. By using both game designers and pedagogy, serious games that focus on a learning topic can be developed (El-Nasr & Smith, 2006). These games can be tailored to student needs and subject matter.

The third and easiest method of integration is using commercial off-the-shelf games (Van Eck, 2006). Using titles that are popular allows for serious games to be used in education. Students are often familiar with these games. The instructor needs to be aware of the learning goals that content that is to be learned. Using serious games in this manner allows the positive learning outcomes to be achieved. However, knowing which game to use, when to use the game, and how to use the game is essential. The educator must carefully consider the game before deciding to use it (Van Eck, 2006).

Evaluating Serious Games

When using games in education, the game must first be evaluated so the maximum learning from the game can occur. There are many different areas to consider about the game before making a decision of if and how to use the game.

The learning goal must be identified before choosing a game. The learning goal or outcome must be clear to the teacher and to the student. Serious games used in education, should not just be played. Rather, the educator must focus the reason for playing the game so that greater understanding of the game can be had. Students must also know the reason for playing the game so they can reflect on the learning goals (Dorman, 1997).

Dorman (1997) also recommends that the students playing the game must be considered. The player must be kept in mind when choosing the type of game, nature of involvement, difficulty, competition, and duration. The player's age and previous experience will determine the above decisions.

It is also important to consider the hardware needed for the game. Not all educators will be able to use the serious game due to hardware limitations. Money to purchase software may also be a problem for some educators. When faced with these dilemmas, alternate ways to incorporate the serious game may be examined (Dorman, 1997).

When considering serious games to be used for education, it is important to consider prerequisite knowledge needed to play the game. The content of the game should also be examined to make sure that there is not inaccurate or missing information. Missing or inaccurate information does not mean the game cannot be used; rather the educator must be aware to lead a discussion with the students. The inaccurate or missing information should not be presented in extra readings or through lecture. Rather, it should be discussed as

players play the game. The player will then be able to make connections between the game

and what information is missing or inaccurate (Van Eyck, 2006).

CONCLUSIONS AND RECOMMENDATIONS

This review examined serious games and their learning potential. More research needs to be done on the effectiveness of integrating games and game play into the classroom. There seems to be little research conducted on the integration. The majority of research conducted thus far appears to look at the potential benefits of serious games but there is little empirical evidence. Many researchers agree on the benefits of serious games, yet the majority of literature reviewed discusses the positive outcomes without empirical data.

Serious Games Defined

Incorporating the learning that takes place during the video games encourages learning and leads the games to be called serious games. While many games are designed with an educational component, not all serious games were designed to be educational. The term serious games is used to represent a wide variety of games and more importantly the outcomes of the games.

There are many games and genres available to students. The genres and classification of serious games is constantly evolving. The different genres are used differently for education purposes. Some of the games involve many players while others are played solo. The games include fantasy locations to real-world simulations. The category of game used depends on students' preference as well as the desired learning outcome. One category does not seem to have more benefits than any other. However, the area of alternate reality games is a growing area that many educators will find beneficial.

Benefits and Learning Outcomes

Parents are encouraged to become more informed on the games their children are playing and the potential benefits of the games when used correctly. For now, the vast

majority of game play occurs outside the classroom walls. Parents need to be informed on creating a balanced life for their child that can include game play as a way of educating their student.

There are many learning outcomes from playing games. Many of these outcomes are valued in education as skills needed to be successful. These outcomes include social interaction, collaboration, creativity, and decision making. Playing serious games and using games can help students develop these skills that are valued as important in society and education.

Disadvantages of Serious Games

Educators and parents also need to be aware of potential risks from playing video games. These can be minimized by limiting time spent, careful selection of titles, and by being informed of the risks. Children playing games should also be monitored by adults to limit negative effects of video game playing.

More research also needs to be conducted on the dangers of using video games. Many studies disagree on the negative aspects of playing video games and whether they really exist. The polarizing issue of the influence of violence in media on children continues into the realm of serious games. Until there is more consensus on this polarizing issue, parents and educators will continue to worry about the use of serious games. As long as educators and parents monitor serious games, the disadvantages can be avoided while the benefits reaped.

Gaming Characteristics that Support Best Practices

Educators also need to become more informed on the benefits of serious games. They especially need to realize the principles of serious games that make them engaging and

motivating to kids. These principles should be incorporated into educating students. They are being used by game designers to hook consumers. These same principles can be used to hook students. By looking at the principles of serious games that engages students, educators can and should use these principles and incorporate them into their lessons. While there was not always a direct link to educational best practices and serious games in research studies, there were principles in games that make them appealing to students. Using these gaming principles, educators can improve the education students receive. Students will become more motivated and develop better, critical thinking skills. Many of the principles of serious games have had empirical research to show educational improvement, but it was not always directly linked to serious games. More research on the use of the games and the principles need to be done to link serious games and educational improvement. By incorporating these principles into education, educators can better educate their students.

<center>Factors to Consider When Using Games</center>

Once the benefits of games have been realized, it is important for parents and educators to carefully select and use games for educational purposes. The potential power of the games is correlated with how the games are used. Discussions about the game and reflective thinking by players enhance the outcomes of the games.

Games must also be chosen correctly. Not all games have the same learning potential. Parents and educators must consider the desired outcomes before selecting games. The games must also be age appropriate and useable. Once the game has been reviewed and the potential examined, the learning outcomes are limitless for serious games.

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