EFFECTIVENESS OF GAME-BASED LEARNING

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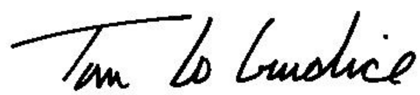

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Andrew Posselt

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Abstract

EFFECTIVENESS OF GAME-BASED LEARNING

Andrew Posselt

Under the Supervision of Tom Lo Guidice, Ph.D., Professor Emeritus

In 2013, video games generated over 93 billion dollars in revenue (Gartner, 2013). In contrast, the motion picture industry generated less than $36 billion dollar domestically (MPAA, 2014). With video games becoming more and more popular, we've seen video games being used for reasons other than just entertainment. The term "gamification" was first coined by Nick Pelling in 2002 (Jakubowski, 2014). Generally speaking, gamification is the use of game mechanics for non-game applications (Deterding, Dixon, Khaled, & Nacke 2011). Game-based learning is a sub-set of gamification, and it refers to the use of games to support learning (Perrotta, 2013). There have been a number of studies in recent years that explore the effectiveness of games with learners of all ages. Researchers have explored how game-based learning effects motivation, learner performance, and collaboration when compared to traditional instructional methods.

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Chapter One: Introduction

In 2013, video game generated over $93 billion dollars in revenue (Gartner, 2013). In contrast, the motion picture industry generated less than $36 billion dollar domestically (MPAA, 2014). With video games becoming more and more popular, we have seen video games being used for reasons other than just entertainment. The term “gamification” first popped up around 2003 (Jakubowski, 2014). Generally speaking, gamification is the use of game mechanics for non-game applications (Deterding, Dixon, Khaled, & Nacke 2011). Game-based learning is a sub-sect of gamification, and it refers to the use of games to support learning (Perrotta, 2013). There have been a number of studies in recent years that explore the effectiveness of games on learners of all ages. Researchers have explored how game-based learning effects motivation, learner performance, and collaboration when compared to traditional instructional methods. Advances for game-based learning are happening both in academia and the work place. In certain fields, such as health care, it is not realistic to train on real patients having real emergencies. Clinical and hospital staff need to be properly trained for these potentially life or death situations, and have been using different types of simulations to train staff for years.

In recent years, some institutions are turning to game-based simulations to train their staff. Sepsis, a potential deadly biological reaction that kills over 200,000 American a year, was the number one cause of mortality at Stanford University Hospital (Shieh, 2013). Training instructors, working closely with doctors and computer programmers, developed a game called Septris. Septris was designed as a simple and highly accessible elearning application that uses game mechanics to train doctors how to identify and properly treat sepsis. The name Septris came from combining “sepsis” and “Tetris” because the two games share common elements. A static patient avatar (that is, a computer generated character) appears on the top of the screen with a list of symptoms. The patient avatar slowly begins sinking to the bottom of the screen. The learner has to choose from several possible actions and treatments. If the learner selects the wrong action, the patient avatar sinks even lower. If the user selects the correct action, the patient avatar will begin to rise. If the patient avatar reaches the bottom of the screen, they die. If they reach the top of the screen, they are successfully treated. As in real life, diagnosis and treatment are a series of interdependent steps. Successful steps by the learner will save (or kill) the patient avatar. Not all of the patient avatars have sepsis, and none of the patient avatars have the exact same symptoms, so learners must evaluate each patient on a case by case basis. Providers could play the game on their mobile phones as many times as they liked, and were awarded Continuing Medical Education credits for playing. In fact, anyone can search for Septris online and play it from their home computer. Pretest and posttest comparisons found that learners were 13% better at identifying and managing sepsis at posttest. Also, over 80% of providers and residents would recommend the game to others as a viable training tool (2013).

The effectiveness and the acceptance of gamified simulations are increasing as instructors and game designers craft platforms that are both educational and engaging. To better understand game-based learning, it must be scientifically quantified and compared to other forms of education. Teachers must identify pros and cons of game-based learning, as well as best practices. The purpose of this study is to review some of the existing literature about game-based learning and determine its pedagogical effectiveness.

This study is significant because it draws on a wide variety of sources ranging from peer reviewed journals to interviews with industries experts and researchers. Based on these sources of information, this study will draw conclusions for best practices as well as limitations of the medium. This study drew its conclusions from a combination large scale meta-data, small group statistics, and firsthand accounts. This study also explores uses in both post-secondary education as well as professional workforce training.

Statement of the Problem

The problem to be addressed is: to what extent is game-based learning an effective methodology for adult learners?

Definition of Terms

Gamification – The use of game design elements in a non-game context (Deterding, Dixon, Khaled, Nacke, 2011)

Game-based Learning –the use of games to support learning (Perrotta, 2013)

Adult Education – Providing or coordinating purposeful learning activities for adults

Serious Gaming – video games used for non – entertainment purposes (Hess & Gunter, 2013)

Delimitations of Research

The research was collected over a year long period referencing to resources found through the Karrmann Library using the key terms “gamification”, “game-based learning”, “methodology”, and “adult education.” Primary sources will be found through EBSCOhost with PsycArticles, Google Scholar, and ERIC as primary resources. All peer reviewed research cited in this paper can be found through EBSCO. EBSCO contained all of the abstracts, but occasionally the full text could only be found on other search engines, such as Google Scholar. EBSCO was the most useful database and was the starting point for nearly all of the research.

Method of Approach

A review of literature related to game-based learning was conducted. The focus was specifically on adults, game mechanics, and how those game mechanics impact adult learners. At the end, there will be a summary of the effective of game-based learning on adult learners.

Chapter Two: Review of Related Literature

The review of literature looks to examine the effectiveness of game-based learning in adult education based on a variety sources. The review of literature has been expanded to include additional information from game developers, software experts, and workforce professions who use game-based platforms to train their employees. This study is intended for educators and training instructors who teach adults in either post-secondary education or adult professionals within the workforce. The findings are particularly relevant for training adult learners working in healthcare. The study will explore the history of video games as a form of entertainment and as an educational modality. It will identify the individual mechanics of video games and how they influence player behavior. Based on these findings, the study will then explore both the limitations and best uses for game-based learning in adult education.

Video Games as Entertainment

As stated in the introduction, video games are a popular form of entertainment. Video games are notably different from other forms of entertainment in several ways. Reading books, watching movies or television shows, and listening to music are passive activities. The participant takes the form of a consumer. In video games, participants take an active role in the story line. Instead of reading about a main character, the participant *is* the main character. They operate within the construct of the game and play an active role in how the story ends. Video games have also benefitted from recent advancements in technology. Graphics and special effects are only one aspect. The move to online gaming means that players from all over the world can tackle objectives synchronously as part of a team. Online collaboration is a key ingredient of today's most popular games. Another positive technological aspect of today's video games is accessibility. Over half of all video games are played on mobile devices

(Entertainment Software Association, 2014). Games like Angry Birds have been downloaded more than two billion times since it first appeared in 2009. This level of accessibility has also coincided with an increase in the average age of a video game player. According to the same 2013 market research from the Entertainment Software Association, the average age for a video game player is 31 years old. The same research shows that the majority of video game players are over the age of 18. This is an important point when considering game-based learning for adults. Though the millennial generation grew up playing video games and using the internet, previous generations learned how to use current technologies later in life. The term "digital native" is used to describe someone who grew up using these technologies, while most adult learners would be characterized as "digital immigrants." those people who did not grow up using the internet or playing video games and learned how to use them when they were adults rather than children. It is assumed that game-based learning would be a natural activity for digital natives. This paper, however, will be restricted to adults, who are mostly (but not necessarily all) digital immigrants and may have been exposed to games later in life. This paper is also applicable to young adults whom might be considered digital natives.

Video games are also distinctly different than simulations. Simulations are interactive, computer based environments that imitate the real world (Merchant et al., 2014). Simulations, while used as a training tool, do not have any entertainment value. Simulations are often used as a test environment where users can practice situations that would be unsafe or cost prohibitive in the real world. Flight simulators and electronic animal dissections would be two examples. Video games do use elements of simulations, like the creation of realistic environments and the user driven experience, but their intention is to entertain, rather than educate, the user. In order to entertain users, video games (as well as all forms of entertainment) must be inherently engaging.

Conversely, simulations are not necessarily designed to be engaging, or at least not in the same vein as video games. To accomplish this, video games use what are known as “game mechanics” to entertain and engage users.

Game Mechanics

Game mechanics are the elements that constitute a game. Furthermore, gamification is the use of game mechanics for non-game applications. Game-based learning, which is a distinct subset of gamification, is the use of game mechanics for educational purposes. While this paper will be limited specifically to video game mechanics, these same mechanics can often be found in other forms of play. In order to examine the impact of game-based learning on adults, game mechanics must first be defined. While there is no single definitive source of what constitutes a game mechanic, a study of numerous journals reveals a pattern of common game elements that many popular games share.

Storylines.

A key game mechanic is a storyline. In technical terms, this is defined as conditional changes in the game state (Denner, 2013). Similar to a storyline in a movie or a book, a video game storyline will have a protagonist who must negotiate obstacles and complete tasks. With video games, the player *is* the protagonist. Rather than reading about or watching the main character, the player is the main character. Denner also identified this as player – controlled movement (2013). The player is immersed in a particular environment and must choose how to react. This can result in multiple potential outcomes. This is similar to a player’s experience in a simulation, but storylines are typically richer and more complex, with plots, subplots, backgrounds, multiple players, and multiple characters. They are geared toward entertainment and engagement.

Epistemic Frames.

Epistemic frame hypothesis suggests that specific communities have their own distinct subculture, with their own set of skills, knowledge, values, and identity (Rhode and Shaffer, 2004). It also suggests these elements works together to create an immersive environment were new members learn and become indoctrinated. Epistemic games, therefore, looks at how these communal skills and knowledge are linked, and how they influence a player's decisions within that framework (Shaffer, 2009). They translate the values, skills, and identity, of a particular profession, into a game. In these types of games, players not only learn specific skills, but acquire an identity. This sort of immersive role playing provides the player context for their actions and is far more realistic. Users are not acting simply as players, but rather as epistemic professionals within a virtual world. In the epistemic game *Urban Science*, players are given the role of urban planners. Beyond the procedural tasks of building, players must operate within a budget, interview stakeholders, listen to citizen feedback, create proposals for redevelopment, and perform many of other real life duties of an urban planner. The game is also multiplayer, where professionals within the field can act as mentors and guide development decisions. Researchers tracked and coded the players performance over the course of four weeks by collecting the work done by individual players and documenting mentor interactions. Researchers also coded and measured the mentor's decisions within the epistemic framework of the game. At the beginning of the game, the players and the mentors made very different decisions. As the game progressed, mentored players began making construction decisions that were much more similar to those of the mentors, meaning that the players were embracing the epistemic frames of their mentors. In other words, they were playing and acting like professional urban planners. These results were also compared to a control group who played the game, but did not get access to professional mentors. The building decisions of the control group varied widely compared to the mentored players, meaning that even though the control group was planning the same game about urban planning, they were not behaving like urban planners because they lacked the epistemic context of the mentored players. Researchers argued that mentor interaction should a mandatory element of any epistemic game. Epistemic games are based on user immersion, but augment it with the added dimension of mentor interaction to give the players a much more realistic, and educational, experience.

Leveling up.

A game mechanic found in nearly all games is commonly referred as leveling up. Leveling up refers to the character's proficiency within the game. Video games are typically easy at the beginning and become progressively more difficult. Thus, a novice can begin the game and become acclimated before moving on to more challenging content. The higher a player's level, the more proficient they are within the game. A study from Finland in 2010 explored how game mechanics drive user behavior (Hamari & Lehdonvirta, 2010). They found that as a game becomes more difficult, players will adapt the way they play. In order to progress through the game, players must adapt to the challenges. Furthermore, these challenges, which are sufficiently difficult for the player's given ability, encourage continued game play. The players can adapt through a variety of methods, ranging from increasing skills and abilities or acquiring new items. The same study also mentions that leveling up serves as a *status restriction* for players, meaning that low level players do not have access to the same content as higher level players. The challenges presented to the player are appropriate for their level, thus they will not encounter challenges or situations that are beyond their abilities. Making games too easy can result in boredom and a loss of interest (tic tac toe would be a good example) (Csikszentmihalyi, 2000). Conversely, making a game too difficult can result in frustration, at which point players will become disinterested and stop playing. Cognitive psychologists call this the *regime of competence* principle (Anetta, 2010). Well-designed games keep players at the edge of their skill levels and abilities.

Points systems.

A points system is a common game mechanic found in nearly all video games. The points system is essentially a rewards system that rewards certain behaviors and punishes others (Gordon, Breyshaw & Grey, 2013). This incentivizes players to choose certain activities over others. Points systems can be in the form of leader boards, score boards, points, virtual money, or other virtual items like treasure, equipment, or weapons. It can also add an element of competition to the game (2013). Rewards also serve as a formative feedback mechanism. Feedback often in the form of points is awarded in real time and lets the players know immediately if they are succeeding or failing. Another variation, or extension, of the points system is economies within the game. In 2010 psychological study of serious educational games, Leonard Annetta defines economies as the ability to buy and sell game artifacts (Annetta, 2010). These artifacts contribute to the player's continued success, and are therefore a way of measuring progress. They also function as incentives.

Failure.

Failure is also a key mechanic of nearly all games. Failure in gaming terms means the ability to attempt a task multiple times until the player is successful (Gordon et al., 2013). Having multiple attempts creates a safe, low – risk environment that fosters exploration and mastery. Failure offers students an opportunity to adapt their methodologies and build on previous knowledge (such as what worked versus what did not work). A well – designed game, utilizing multiple game mechanics will create an environment that is highly challenging, but low stress. Games that are easy to play, yet difficult to master. Users repeatedly fail but they are incentivized to keep playing. Casinos are a good example of this phenomenon. The odds always favor the house, but there are enough incentive rewards to attract players.

A good example of using failure in educational games came from a game developed by University of Wisconsin and Massachusetts Institute for Technology. *Environmental Detectives* is a mobile, multiplayer game designed to teach environmental sciences to college students (Squire, 2008). Students played the game on hand held devices that used GPS coordinates to guide the students to real world locations. Students had to find the source of a virtual toxin within the local ecosystem, and suggest a plan of action on how to address the issue. To begin the game, students physically went to these locations and investigated for possible toxins within the environment. Once the students discovered these virtual toxins, the game required the students to do research outside of the game. Students had to independently research the nature of the toxins, the health effects, possible sources, and historical records from the area. Based on these findings, students had to develop a method for fixing the problem. Failure, in several forms, was a common occurrence in the game. Students had to try different methods for identifying the toxins, many of which did not work, or gave an incomplete picture of the problem. While most students could correctly identify the toxins, few could identify the source of the toxins nor develop an effective strategy for remediation. Students also learned that some strategies from remediation were more effective than others. Students were often looking for a singular answer that would solve the problem, but, as with real world environmental issues, there are often no easy answers. The game posed an open-ended question and presented a problem that often did not always have a definitive solution. “Mastery” was allusive. Groups who were the most successful learned to combine different methodologies and compare numerous sources of data.

It should be noted that a video game does not need to exhibit all of these mechanics in order to be classified as a game. The popular Nintendo game Tetris did not have a storyline, but has other of the aforementioned mechanics. The purpose of these mechanics is ultimately to entertain, and therefore engage, the player. It is this element of user engagement that makes game an attractive modality of adult education.

Games as Educational Tools

The first known use of “gamification” as a term was in 2003 (Jakubowski, 2014), but did not gain much traction until several years later. This means that much of the research used in this paper is of a recent nature. Computer games, however, have been used in classrooms since the mid 1970’s. *Oregon Trail* came out in 1974 and introduced students to American westward migration. In the game, students play the role of settlers as they followed the Oregon Trail. Students had to make numerous decisions along the way that would determine their success or failure. Players had to hunt and forage for food while contenting with diseases and lowering group moral. Students learned about how settlers lived and what they experienced along their migration through immersive game play. In 1985, *Where in the World is Cameron Sandiego* taught geography to millions of students (Sitzmann, 2013). Players were tasked with pursuing and ultimately arresting Carmen Sandiego. Players were given clues about Carmen’s location, and they would have to use those clues to select their next location. Similar to *Oregon* Trail, the player’s chooses would determine whether or not they succeed in catching Carmen. Each time the player selected the correct location, they would learn something about that geographically area while being given additional clues about Carmen. Using computer games to teach is nothing new, but there has a proliferation of literature in recent years that seeks to define and quantify the useful of games in (and outside) of the classroom. The advantage to this recent surge is that most literature on game-based learning is very current; typically less than 4 years old. Conversely, there isn't as much meta – analysis or pretest/posttest studies as seen in other topics. There are several recurring themes that appear in the research of game-based learning.

Traci Sitzmann of the University of Colorado Denver conducted one of the first meta – analytic examinations of game-based learning in 2011 (Sitzmann, 2011). This study has been widely cited in numerous journal and reports since its publication. The focus of the study was how game-based simulations impact adult learners in a work environment. The study contained 65 independent samples from more than 6,000 learners. These learners were compared to a comparison group that either received alternative, non-game-based instruction or no instruction at all. Sitzmann found statistically significant positive impacts on learning outcomes for learners who used game-based simulations over learners in the control group (2011). She also was able to point to specific gains among the learners. The highest gains were in self-efficacy (20% increase), procedural knowledge (14% increase), declarative knowledge (11% increase), and overall retention of knowledge (9% increase). Self-efficacy is a post-training metric that refers to the learner's confidence level in his or her ability to perform the tasks that were learned in class. Sitzmann argues that the highly interactive nature of game-based learning breeds more familiarity with the subject matter than traditional passive instructional methods. While learner confidence was noticeably higher among game-based learners, it could be argued that procedural knowledge, declarative knowledge, and retention are more important measure because they measures actual performance rather than learner reaction and emotion. Sitzmann states that declarative knowledge is the ability to remember concepts and relations, while procedural knowledge measures the learner's ability to perform an actual task or procedure. Sitzmann also states that the increases in knowledge and retention are due to the fact that game-based simulations attempt to direct cognitive and affective processes within the learner, meaning that they engage the learning in an active, rather passive, manner that fosters repetition and familiarity with the material.

Another significant finding was how game-based learning relates to other traditional educational methods. A 2013 study from Texas A&M found game-based simulations were more effective when used in conjunction with other forms of traditional education rather than as a stand-alone delivery method (Davis, Merchant, Goetz, Cifuentes, & Kennicutt, 2013). This is also consistent with Sitzmann's findings (2011). The study found that game-based simulations maximized their effectiveness when they were used as a practice tool to supplement the traditional lesson (Davis et al., 2013). The same conclusion was reached by other studies (Fu-Hsing, Kuang-Chao, & Hsien-Sheng, 2011) that show that while game-based simulations are effective as a stand-alone delivery method, they are even more effective when supporting traditional classroom methods, such as lecture. If game-based simulations are used as the sole delivery method, without supplementary classroom material, the evidence shows that students with prior knowledge of the subject performed better than students with no previous knowledge (2011). Furthermore, students with no previous knowledge of the subject matter do worse with stand-alone game-based simulations than they would in a traditional class (2011).

The number of attempts while playing a game also had a statistically significant impact on learner performance. If learners could play the game multiple times, as opposed to only being able to play once, they had greater educational gains (Garris, 2002). Thus, the more that the learner was exposed to the material, the more opportunities they had to apply and synthesize the material.

This coincides with the game mechanics of failure, where players can make multiple attempts and learn from their mistakes. The concept of multiple attempts is only effective if the learner was motivated to continue (Fu-Hung, et al., 2011). Motivation to continue is due in part to a player's ability (2011). Player ability is how well a learner can play the game itself. Research shows that if learners struggle with basic game navigation and execution, then their learning suffers as a result and they are less likely to continue (2011). Conversely, learners who are more adept at playing video games demonstrate greater gains in directive and procedural knowledge. Some researchers have challenged these finding, stating multiple attempts using any instructional method tend to yield better results than using singular, one shot training activities (Wouters, van Nimwegen, van Oostendorp, & van der Spek, 2013). However, as stated in Chapter One, repeated attempts are an inherent element of game-based learning activities.

Limitations.

Research has also found some important limitations and considerations for game-based learning. For example, a 2013 study by the United States Army Research Institute for Behavioral and Social Sciences, researchers found game designers must strike a balance between game play and instruction (Belanich, Orvis, & Sibley, 2013). If a game-based simulation focuses to heavily on instruction, it fails to motivate and engage learners, at which point it has the same instructional effectiveness as any other traditional delivery method (2013). The same study found that user engagement and motivation were increased when game-based simulations had sufficient levels of challenge, exploration, and realism. Conversely, learner performance suffered when simulations weren't realistic and sufficiently challenging. These finding seem to validate that the game mechanics of storylines and leveling up can enhance the users engagement by enforcing Anetta's regime of competence principle (Anetta, 2010). Conversely, other studies have found that learner performance suffers if game mechanics and play are over emphasized (Fu-Hung, et al., 2011). A 2011 study from Taiwan found that some users, who were identified as having previous game playing experience, performed poorly in knowledge acquisition because they were more focused on game play elements such as getting a high score and winning (2011). In this case, game play was a distraction from the educational content rather than an enhancement of it. It should be noted that these same users had low levels of learning motivation prior to playing the game. So they while they were motivated to play the game, they were not sufficiently motivated to learn. This is in line with other research that found when competition was emphasized (which is a common element of many games), it could have a clearly negative educational impact on some users (de – Marcos, Pages, Dominguez, Saenz – de – Navarrete, 2014). Some users focused on winning over learning, and other users lost motivation to compete, and therefore lost interest in engaging with the content as a whole (2014). Some researchers have attributed this to the experience of "flow", which is characterized as a state of intense focus and engagement that is both challenging and enjoyable (Csikszentmihalyi, 2008). For example, a 2013 study on the motivational aspects of educational games found that instructional elements disturbed the flow of the game (Wouters, et al., 2013). In one scenario, pop – up screens that asked learners to reflect on the content interrupted the flow of game itself, undermined the entertainment value, and drove down engagement (2013). The researchers contend that games that emphasize entertainment (and therefore, engagement) do not naturally support instructional design (2013). Other studies conflict with this theory (Sitzmann, 2011;

Belanich, et al., 2013; & de – Marco, et al., 2013), which speaks to the different methodologies of the studies involved.

While meta – analysis of game-based simulations finds that they are more effective in terms of educational objectives than conventional teaching methods, research also found that the do not improve learner motivation (Wouters, et al., 2013). Generally speaking, this research found that levels of motivation did not significantly improve if learners were using a game-based simulation or if they were participating in traditional classroom instruction for the same content (2013). An exception to this rule was that game-based simulations were more motivating when they are not combined with other forms of instruction. So while game-based simulations are more educationally effective when combined with other forms of instruction, students are less motivated to play (2013). The study argues the compulsory nature of traditional education limits the learner's self – determination and freedom, and therefore adversely impacts their motivation. This is similar to research done by the United States Army, who found that lack of control negatively impacted learner motivation (Belanich, et al., 2013). Learners also cited games that were too challenging, not challenging enough, or that weren't realistic all drove down levels of motivation. As previously stated, making games too difficult or too easy is a failure of game design, which is a result of the methodology used on this particular control group. The same study did show that learners were more motivated when the game-based simulations were sufficiently challenging, and offered learners the opportunity to explore and control the experience. Games that were challenging had a higher motivational factor than the other metrics.

The 2013 Wouters study contradicts the findings of a 2013 study published in the British Journal of Educational Technology that found that game-based learning did increase learner motivation when compared to control group (Hess & Gunter, 2013). Both studies surveyed learners' self-described motivation, but the Hess study also found that learners of the game-based test group voluntarily interacted with more of the content than did the control group. The game-based group also spent more time with the content, though it is unclear why. Ultimately, the game-based group that used game-based learning methods had higher motivation and did better academically then the control group. However, the researchers were clear that they did not find a causal relationship between motivation and performance.

Best uses.

Game-based learning also seems to be better suited for some uses over others. Much has been made of the collaborative nature of online gaming and researchers have examined if this collaboration has translated to the game-based learning. Recent research has found that learning outcomes are higher if students played the games by themselves rather than with other students (Merchant, et al., 2013). This has conflicted with other research that found learner outcomes were higher when students worked in a group rather than alone (Wouters, et al., 2013). A meta – analysis of data from 5,547 participants showed educational gains for both individuals and groups, but the group learners had higher gains in knowledge, skill, and retention (2013). The researchers propose that playing in a group encourages other types of learning activities that do not normally occur while learning alone (2013). It should be noted that the sample sizes, demographics, and game design differed between the two studies. As Sitzmann reported in her research, learners had greater educational gains in procedural knowledge over declarative knowledge (2011), meaning that game-based simulations were better suited for performance based learning rather than knowledge or comprehension based learning. An earlier study from Wouters also found while learners had gains in declarative knowledge, they had greater procedural knowledge gains (Wouters, van der Spek, & van Oostendrop, 2013). This particular study used a game-based simulation to teach students how to triage patients in a health care setting. Comparing pretest and posttest results showed greater gains when students had to apply lessons rather than simply recall information. These findings are backed up by a later Wouters study published in the Journal of Educational Psychology that found that performing tasks in a simulation mirrors the cognitive functions seen while performing the tasks in the real world (2013). This is consistent with other studies that have found significant improvement for skill based outcomes over knowledge based outcomes (Merchant, et al., 2013). These results specifically came from game-based learning activities. Researchers hypothesized since video games require interactivity through virtual kinesthesia, they are better suited for skill based outcomes. The same research found simulations that did not use game mechanics failed to produce statistically significant learning gains over the control group.

Chapter Three: Conclusion and Recommendations

All of the research that was examined unanimously showed a statistically significant increase in educational performance when game-based learning is compared to traditional instructional methods. A common theme in nearly every study was that the researchers agreed that more research was needed on the effects of game-based learning on adults. While learners had clear gains in procedural knowledge, descriptive knowledge, and retention, researchers did not specifically state what elements of game-based learning help facilitate these results. For example, none of the research explored how individual game mechanics influenced specific learning objectives. Therefore, researchers were not able to identify causal relationships between game-based learning and increases in educational performance. The researchers were only able to establish (strong) correlations. Part of this stems from the different methodologies used in game-based learning. Interpretations of game mechanics can vary greatly, and quantifying their effect on learner performance was even more difficult, which also might explain why some studies had conflicting conclusion about motivation and collaboration. Game design varied considerably from study to study, which might have created variance among the results. One thing that all the researchers agreed upon was that academic performance was greater for learners who used game-based lessons than for learners who had traditional instruction alone. It was also true that learners had the greatest educational gains when game-based learning activities were combined with other forms of instruction, including lecture and discussion. Learners had further educational gains if they were able to play the game-based simulations multiple times as opposed to only playing it once. Several studies also found that game-based learning was best suited for procedural knowledge where learners had to apply or demonstrate what they learned. Learners still had educational gains for declarative knowledge, but not as high as those for procedural lessons. It should also be noted that none of the studies cited the cost or development time for the game-based simulations. So while game-based learning might be highly effective, teachers might not be able to use them due to potential budgetary and architectural constraints. However, many companies and universities are already creating games that are specifically designed to be used by instructors for a wide range of topics. In addition, the University of Wisconsin recently received a grant to build authorware so that teachers and other laymen can build their own game-based lessons (Shaffer, D. (2015, March 9). Research interview [Telephone interview]). Several studies emphasized the important of professional game design married with proper pedagogy. The theory is that simply turning a traditional activity into a game will not increase its effectiveness. In game-based learning, this is referred to as "chocolate covered broccoli" (Shaffer, 2015). The theory is that simply covering poor pedagogy with game mechanics will not improve the lesson. Solid lesson planning and instructional design must be blended with effective game-based mechanics. They are equally important. Another important finding from the research that none of the studies found game-based learning to be less effective than traditional means of instruction, regardless of methodology. At the very least, learners made minimum gains that were equal to those of the control group. No study found a failure to demonstrate educational gains, which means that game-based learning is at least as effective as other traditional methods of education. This was true even when learners were intrinsically unmotivated and lacked game playing skills.

Based on these findings, it is recommended that more research be conducted to examine how specific game mechanics influence learning behavior and determine causal relationships between the mechanics and the outcomes. It is also recommended that more research is needed on best practices for game-based learning, specifically exploring if game-based learning is better suited for specific subject matters or learner types. Based on these current results, it is recommended that game-based learning activities be used to supplement and emphasize lesson plans. In other words, they should be incorporated and combined with existing methodologies, rather than be used as the sole method of instruction. It also recommended that games incorporate aspects of Universal Design. In a 2015 interview, University of Wisconsin-Platteville computer science Professor Lisa Landgraf stated how educational games could be one of several options presented to a student. When competing a required project, students could choose between completing a game-based simulation or a more traditional educational modality, like writing a report or giving a class presentation. Giving students more options would expand the student-centered experience. Furthermore, it is recommended that game-based activities be used to achieve procedural, application based learning objectives as applicable. It is also recommended that learners have open access to the game-based activity, preferably both asynchronously and synchronously, and that they not be required to log a specific amount of time or number of attempts. The game mechanics of failure and the value of allowing multiple attempts appear to encourage learner exploration and increase the time spent with the material.

Some research has also shown that games are particularly well suited for assessment, as well as learning. David Williamson Shaffer at the University of Wisconsin argues that video games "are nothing but good assessments" (Gee & Shaffer, 2010). Video games are built around problem solving and overcoming obstacles. In order to solve these problems, players must adapt and overcome them before they can proceed. The game mechanic of Leveling Up means that games can access whether a player is ready for the next set of challenges. Video games also collect, track, and report information on players over time. The information is both formative and summative, and can be used by both the player and administrators to measure performance.

Thus, it is recommended that video games be used both for learning as well as student assessment.

There are several implications for healthcare in particular. The practice of medicine is a very hands – on, kinesthetic discipline. The ability to repeatedly practice patience care scenarios can give providers and staff the ability to become familiar with a wide range of health issues. In an environment where misdiagnosing patients can be fatal, the ability to properly identify alignments can sometimes take years of experience. Games like Septris add valuable experience and expose providers to situations that they might not normally see. Game-based simulations can also be scenario based and involve numerous staff, not just a single player. Test patients can pass through registration, scheduling, rooming, and into treatment through a virtual environment where multiple players facilitate the process and work together. An issue or hold up at one spot would affect the entire process. These game-based scenarios would give staff valuable, safe experience while at the same time using game mechanics to encourage proper behavior and discourage actions that might be wasteful or dangerous. Since game-based learning is best suited for procedural knowledge, it is a natural fit for areas like health care and clinical operations. Dean Clinic in Wisconsin is currently using a platform called the Cyber Clinic to train clinical workflows to its new employees (Posselt, 2014). The Cyber Clinic is a game-based simulation that uses computer generated avatars to simulation patients who are in a clinical environment. Patients appear on the screen, and the player must choose the proper course of action based on the patient's needs. The player will execute the action in the clinic's electronic medical record software, called Epic. There are several scenarios that have various levels of difficultly. Dean Clinic has plans to develop a mobile version of the Cyber Clinic using an open-source application called ARIS. ARIS is a mobile application created by the University of Wisconsin that is designed for both the creation and playing of Augmented Reality games. Teachers or students can log into ARIS's online editor website and create games through a user friendly interface. To play the games, players can download the ARIS app for free on iTunes.

Game-based learning can also have potential implications for direct patient care. Scientists at John Hopkins Hospital worked closely with neurologists and game developers to create an immersive game called "I am Dolphin" to help stroke victims relearn motor skills that have been lost due to brain damage (Shmuelof, 2012). In the game, players who are stroke victims control the motion of a computer animated dolphin through the use of a special prosthetic controller that houses their entire arm. Instead of performing common tasks, like picking up a fork or using a phone, users must perform tasks as a dolphin in a virtual environment. These tasks include catching fishing and warding off shark attacks. The user's physical actions, which can be very limited due to their stroke, are exaggerated onscreen, and give the user a perceived sense of greater mobility. By using different types of formative visual feedback, the game forces users to form new, adaptive motor skills in order to complete the tasks. These new motor skills are then reinforced through repetition. These cognitive adaptations, which primarily occur in the cerebellum, have been shown to have lasting results only if the treatment is conducted on a regular basis. Users who demonstrated improvements in motor skills and cognitive adaptations through playing the game would regress once they ceased regular game play. Nonetheless, patients showed improved motor skills as a result of playing this game. One of the study's authors, Dr. John Krakauer, also mentioned how patients are far more receptive and willing to participate in this type of game-based therapy, as opposed to tradition physical therapy (J. Krakauer, personal communication, June 2, 2015).

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