UNDERSTANDING 3-D SPACES THROUGH GAME-BASED LEARNING: A CASE STUDY OF KNOWLEDGE ACQUISITION THROUGH PROBLEM-BASED LEARNING IN MINECRAFT

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The primary purpose in this case study was to explore the use of three-dimensional virtual spaces via the use of the game Minecraft as a teaching tool. The case study examined the effectiveness, self-efficacy, and social interaction of students when using such a tool in the teaching and learning process. The research analyzed knowledge acquisition through various deliverables such as benchmark pre and post exams, student discourse, and tangible objects created from the lessons by the students. Students were enrolled and participated in a summer camp offered from Arts and Technology Institute in North Texas. The camp utilized Minecraft to teach architecture types. Students learned about pyramids (Egyptian and Aztec), Roman/Greek architecture, Gothic architecture, and Post-Modern Architecture. Each day students were exposed to a different theme of architecture and were tasked with building a world that was in the theme of an assigned type of architecture. Fifty-nine school age students ranging in ages from eight to twelve years old participated fully in the study. The students were not grouped by age, but instead self-selected partners with which to work during the course of their creations.

Results show that students who participated in the Minecraft driven course were highly engaged and reported a positive experience during the course of learning. Participants worked cohesively to achieve common goals and problem solve during the course of project completion. Participants freely participated in discourse that was on the topic of the lesson, as well as, offered suggestions for improvement and solicited ideas from other participants. Pre and posttest results yielded an improvement in knowledge acquisition regarding general
knowledge of architecture types. Many students frequently used the word “Fun” to describe their learning experience as cited in their daily blog entries. The research strived to show that using Minecraft as a teaching tool can create an environment in which students are highly engaged and are afforded an opportunity to learn material in a way that students can see as an applicable reason for learning. Results of this research evidence Minecraft as a tool in learning yields an atmosphere in which students take ownership of their learning and work in concert with other members of the classroom to yield positive learning outcomes.
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CHAPTER 1
INTRODUCTION

In this era of technology, game developers, academic professionals and researchers are more than ever sharing common goals, theories and frameworks with respect to game play and its responsive work. The research by these groups of professionals has begun to examine the importance of the feedback reciprocated by players rooted in the insight of player psychology (Robinson, 2001). A primary reason for continued interest in pursuing research into the use of video and computer game play for learning has been driven by the ever increasing number of children who interact with video and computer games and associated devices on a daily basis (Elliot, 2014).

For example, in 2015, a reported 155 million Americans reported regularly playing video games (Campbell, 2015). Of that population, the statics group, Statista, reported 26% of gamers were under the age of 18 (2015). Further, Statista reported 90% of children in the United States; ages 6-12 play video games (2015). In 2014, Entertainment Software Association (2015) reported U.S. consumers spent over $22 billion on video games (Campbell, 2015). Video and computer games have seen tremendous growth over the past decade (Kapp, 2012) and are forecasted to continue to be one of the fastest growing industries worldwide (Gartner, 2013).

Computer games for learning can be traced back to such as examples as Oregon Trail that made its way into the classroom in the 1990s. Since the introduction of computers and games into the classroom, practitioners have questioned whether actual learning is taking place or if students are only being entertained (Hrabowski, 2015). In 2013, 74% of K-8 teachers reported using computer and video games in their classroom for educational purposes (Vaala,
2014). As research shows that there are some educational benefits of video games for learning (Papastergiou, 2009) more in depth studies can reveal the types of information that can be mined from the use of these video games (Ke, 2008).

This research examined the use of Minecraft to teach the concept of architecture to school age students between 9 and 12. As is discussed, students were tasked to cooperatively building worlds that were aligned with a specific theme of each daily lesson. Specifically method for assessing how students discern complex assignments while engaged in three-dimensional virtual worlds (3-DVWs). Effectiveness, self-efficacy, and student interaction while playing Minecraft in the classroom were examined and are discussed.

The function for this case study was to examine the effects of utilizing the popular game Minecraft within an educational setting to teach students new content. It can be termed poplar as according to Minecraft.net, approximately 15,000 people per day purchase the game and in the last 4 years 19.4 million people bought the game for personal use (Mojang, 2015). This coupled with the recent sale of Minecraft to Microsoft for $2.5 billion in the fall of 2014 illustrates the awesome popularity of the game (Mullholland, 2014).

Need for the Study

Students working collaboratively in an environment of play-to-learn learn better by doing (Papert, 1999). Papert (1999) further posits that students learning through constructive play are learning by doing which effectively transfers learning into long-term knowledge. Play is the quintessence of games as a medium; that is, giving the player an arrangement of difficulties and opportunities for investigation that give upgrading and/or appealing encounters (Papert, 1999). It is this property of a profoundly captivated connection with an underlying recreation
that makes games and different types of computer-based and game-based learning effective, expressive, and exceptional (Mateas, 2001).

Marrying the gaming environment to the education setting is one that is still naïve in its outcomes (Vaala, 2014). Gee (2007, Chapter 1, par. 20) states that the dilemma facing schools and workplaces is “how to get people, often young people, to learn and master something that is long and challenging – and enjoy it.” While many studies make strong claims about the positive impact of computer games for learning, there is a need for systematic examination (Brown, 2008) The type of research conducted in this study has the potential for unlocking the world of gaming and education to reach a result of positive learning outcomes by utilizing a medium in which learners can construct knowledge in a setting that is entertaining and powerful (Sandford, 2006).

Purpose of the Study

Recent developments in game-based learning (GBL) have heightened the need for examination of ways in which GBL may be integrated into pedagogy to yield successful learning outcomes (Egenfeldt-Nielsen, 2011). In the study, effectual consumption of a 3-D environment from the eyes of GBL was examined. This study was formulated to establish whether knowledge attainment, outside of the realm of basic game play, is graspable through the structure of GBL utilizing the tool of Minecraft.

Setting and Methods of Study

The study took place at Arts and Technology Institute (ATI) a non-profit technology school. Archival data was made available from (ATI), ATI primarily serves students in the K-12 age range who are located in Dallas Forth Worth Metroplex. ATI currently has nine instructors
and two owners. Detailed description of ATI is found in Chapter 3. Students enrolled in courses that were examined by the author during this case study participated in ATI’s summer camp program during June through August. During the research time frame, 130 courses were offered by ATI, but for the purposes of this research only classes that utilized Minecraft as a tool for learning were examined.

This research involved primarily qualitative data analyzed using Classroom Observation Code instrument of coding (Abikoff & Gittelman, 1985) to decipher discourse and interactions among students in the classroom. Hahn’s model of qualitative coding was the framework from which the analysis was taken from a broad idea to narrowed topics emerged from the data (Hahn, 2008).

Although most of the research was non-positivistic, benchmark and demographic data analysis served to add a quantitative element of examination to the research. The pragmatic approach to the data analysis in this case study is intended to add value to future research and serve as a foundation from which pedagogy can be designed effectively.

The following research question is posed as the foundation from which the sub-research questions branch. Within the three sub-questions topics examined are effectiveness, self-efficacy, and community of practice.

- Can the use of 3D spaces evoke other knowledge by using tools such as Minecraft?
  - Effectiveness: Is Minecraft an effective tool in acquiring other knowledge when teaching predefined objectives?
  - Self-Efficacy: How is a students’ self-efficacy affected when utilizing game-based learning such as Minecraft?
  - Community of Practice: What kind of social engagements provide opportunity for acquiring knowledge by utilizing 3DVW such as Minecraft?
Assumptions and Limitations of the Study

Research design was forged by personal and phenomenological assumptions. It was assumed participants would be excited to play the game based on their choice to enroll in the class. It was also assumed that the participants put forth their best effort in answering pre and post-test benchmarks as well as their entries to the daily log. This could also serve as a limitation.

In addition, assumptions are made that the supportive literature and methodology presented in chapters 2 and 3 were accurate and correct. It is also assumed that the personal experience of the researcher is utilized when analyzing and expounding student interactions in chapter 4. Still, it is assumed that ATI’s staff provided raw unaltered data. Furthermore the assumption was made that students were given ample time to complete surveys, projects, blog entries, and benchmark assessments. This could have an effect on learning outcomes.

All courses and tests were in conducted in the English language. Students who are ESL (speak English as a second language) may be affected differently than students who speak English as their first language. Learning outcomes may be different dependent on the student’s understanding of spoken or written directions.

Another limitation was timeframe that data was collected. Data was collected during the summer months and courses were only one week in length. This limitation may have its effects on the outcome of the data, as it is a small glimpse of time utilizing Minecraft in a classroom. A stronger representation of data outcomes may emerge if a longer period of time and more students were analyzed.
Although there is an abundance of literature that focuses primarily on game-based learning there is a limited amount of peer-reviewed literature that points directly toward the use of Minecraft in the classroom. A small amount of case studies, however, do illustrate instances where Minecraft has been utilized in a K-12 classroom setting. This was erred to in Chapter 2.

Summary

In this chapter, a brief introduction was provided to the research subject. The problem statement, research questions, and the purpose and need for the study were introduced. Assumptions and limitations of the study such as students’ best effort and student ability to understand directions and benchmark assessment all conveyed in English were addressed.

Chapter 2, Literature Review presents related research and sets the context for the study. Areas such as Minecraft definition, historical and current significance of game-based learning, and theoretical framework supporting the game-based learning model will be covered prior to discussing the research methodology in Chapter 3.

In this chapter a brief introduction of the popularity of Minecraft its potential for game-based learning was proposed. This case study sought to explore the benefits or detriments that 3-D virtual world gaming may provide to educators in K-12 classrooms. Game-based learning environments offer an influential and active framework to create, initiate, and uphold the knowledge to empower structured procedure (Egenfeldt-Nielsen, 2011). This study provides insight into how the game Minecraft as a tool can be used for knowledge acquisition and building positive learning outcomes in K-12 education settings. Minecraft supports the facts-
construction process using three qualities: instructive platform, sited erudition, and collective deriving (Viktor et al., 2013).

On the Minecraft official website game play of Minecraft is described as using blocks of any kind and create building materials produced from the game (Mojang, 2015). David Smeaton, researcher from Griffith University in Australia, has written many works on game-based learning and the use of Minecraft as a tool for learning in the classroom. Smeaton (2014) stated in his research that Minecraft has numerous indicators, which, in turn, are a construction for high-quality learning surroundings. These indicators include construction, obstacles from which to overcome, and demanding errands that thrust kids to persevere to achieve higher objectives. Enthusiasm has been seen over the criteria of creativity for students of all types and teachers can create multiple virtual scenarios for the class (Smeaton, 2014).

The incentive to carry out this study was the exploration of GBL technology and its incorporation with education and research. This study analyzed and explored the results of the utilization of Minecraft to produce other knowledge. Further the case study examined the interactions of students while playing Minecraft in a classroom setting.

Conclusion

With a reported 15,000 purchases of the commercial version of Minecraft daily, its popularity among gamers cannot be argued (Mojang, 2015). Because of this popularity Minecraft among K-12 students, one could posit that students perceive Minecraft to be an effective tool to assist in yielding new knowledge. In this chapter need, purpose, and setting of the study was established. Three thematic areas were cited as areas of analysis and examined.
The following chapter presents supporting research and relates the conceptual and theoretic framework for the use of Minecraft and game-based learning in the classroom.
CHAPTER 2
LITERATURE REVIEW

To identify acquisition of other knowledge through the use of 3-D spaces in game-based
learning, the term “game” within our research is best defined by ludologist, Jesper Juul, as:

...a rule-based system with a variable and quantifiable outcome, where different
outcomes are assigned different values, the player exerts effort in order to influence the
outcome, the player feels attached to the outcome, and the consequences of the activity are
optional and negotiable. (The Game, the Player, the World, 2003)

This definition addresses a trifecta of aspects that are examined when utilizing game-
based learning in the classroom: quality of player experience, structural aspects, and functional
aspects. Arnhart (1998) asserted humans have a natural sense that justice requires benefit for
benefit, have a natural tendency to struggle for power, generally seek social relationships. The
literature reviewed in this section will illustrate that these principles Arnhart claimed are found
within the game-based learning environment.

Minecraft Defined

In 2009, Minecraft was created by Swedish programmer, Markus “Notch” Persson.
Persson developed and published alpha version of the game with the partnership of Swedish
game developing company, Mojang (Makuch, 2012). The full version was available to the public
at MineCon, the annual convention for Minecraft gamers, in the fall of 2011 at a price of 20
Euros (Mojang, 2015). Minecraft now has approximately 100 million registered users and
earned more than $100 million in 2012. This has come through individual game deals and
promotion materials (Makuch, 2014). While 14.3 million of these users are registered PC users,
Minecraft is available in other platforms as well including Xbox 360, Sony PlayStation 3, and Minecraft Pocket edition for Android and iOS platforms (Makuch, 2014). Since 2011, Minecraft has garnered multiple awards and touts the best-selling PC game to date due to its high sales volume and third-bestselling video game of all time (Leavitt, 2013).

Game Play

Players start in an empty virtual space (Figure 1) where they use Lego-like blocks and bricks to build whatever they choose (Smith, 2012). In an interview with Rolling Stone Magazine, Persson says, “It’s about surviving, much like being stuck on a dessert island. You have to build shelter, protect yourself from vicious creatures, and stay alive. The only limit is your imagination” (Peisner, 2014).

![Figure 1. Empty virtual space used for building and resource mining in Minecraft.](image)

The player’s avatar, called Steve, is tasked with surviving in a world with resources that he collects and mines during the game play (Smith, 2012). Steve is tasked with building shelter and collecting resources in order to survive. The game uses block-like structures (cubes) for
building on a fixed grid pattern (Talley, 2014). Each cube can represent a different material such as dirt, water, grass, glass, various ores, and tree trunks (Talley, 2014).

At the beginning of the game the player is placed on the surface of a mechanically generated world that is separated in biomes. Biomes include jungles, desserts, snowy tundra-like fields, or mountain ranges. Gamers use blocks of fundamental building materials collected from the game’s simple multitude of ecosystems (Ashdown, 2010). Players can use source blocks for liquid resources, material blocks, and craft weapons from resources. In addition, users can build electric circuits to emit power by the use of Redstone blocks, flat transparent blocks with the ability to transmit power (Milton et al., 2014).

The game play for the contextual analysis directed in this case study is the video game, Minecraft (Hill, 2014). Minecraft received recognition for its imaginative idea and player-driven story; however, there are some varying purposes to use Minecraft to represent game-based learning in a 3-D Virtual World setting for the purpose of this research (Vaala, 2014). Despite the fact that the condition of the game is in consistent flux because of frequent, continual updates and versions, the primary ideas of the game remain constant (Schifter & Cipollone, 2013). Unlike other video games where the objective is to complete levels or collect points, Short (2012) asserts Minecraft is bereft of any customary featured video game objectives for the players to attain. It places a considerable measure of moral obligation on the players to make their own self-characterized objectives (Short, 2012).

Modes

Minecraft is an open-ended sandbox game that affords players liberties on how they choose to play the game (Hill, 2014). The game consists of four game modes; survival, creative,
adventure, and spectator (Smith, 2012). Within the modes the player can set difficulty level (Leavitt, 2013). Players can play in single player without a server connection or multiplayer mode via server connection (Milton et al., 2014).

In survivor mode players have to gather natural resources found within their environment to build or craft structures meanwhile avoid monsters that may spawn during the dark (Hill, 2014). At this time the player builds shelter or digs trenches to protect themselves from the creatures of the night (Talley, 2014). Talley indicated in his book, *The Big Book of Building Everything Minecraft*, that in this mode the game’s inventory system allows players to carry a limited amount of resources (2014).

Creative mode, Talley stated, like survival mode, requires players to build shelters and craft items (2014). Unlike survival mode players are not required to collect resources but instead they have access to all items in the game (Talley, 2014). This mode helps players focus on building structures rather than worrying with hunger or angry mobs to ward off in the night (Talley, 2014; Hill, 2014). Players are able to freely move about the game by foot or fly without worry of environmental or mob damage (Leavitt, 2013).

Adventure mode was introduces so that players can experience pre-crafted maps but still have the elements of survival mode (Talley, 2014). This mode also adds the command block so that players may manually type commands to expand interactions with players through server commands (Talley, 2014).

Spectator mode allows players to observe game play without actually interacting with any of the other players (Hill, 2014; Talley, 2014). Point of view can be altered as well so that
the player may see things from other player or creature’s vantage point. This mode does not allow players to build or mine for resources (Hill, 2014; Talley, 2014; Makuch, 2014).

**Single Player**

During single-player sessions, players are placed into their own procedurally created Minecraft world at the beginning of the game (Talley, 2014). Cows, sheep, chickens, and other barn animals and hostile mobs populate the world (Figure 2); yet, the principal performers inside the amusement are the blocks that are similar in mechanics to LEGO blocks (Talley, 2014).

![Minecraft 3-DVW screen shot (Herobrine, 2011).](image)

*Figure 2. Minecraft 3-DVW screen shot (Herobrine, 2011).*

With their pixel-like appearance and attributes, they constitute the player's method for creation and development (Hill, 2014). The player can use blocks in diverse ways to create various structures. The blocks have distinctive hues and properties and may be consolidated with different tools to make structures (Hill, 2014). Players can earn resources construct buildings, scenes, visual organizations, or new game components within the original game (Schifter & Cipollone, 2013; Short, 2012).

A player can hide in a little opening in a slope and spend the entire game session inside his isolated fortification without being rebuffed, or—from a strict gameplay point of view—fall
"behind" more dynamic players in game advancement (Makuch, 2014). Minecraft doesn't reward or penalize the player for this strategy. Since there are no objectives, movement cannot be measured (Short, 2012). Yet, players commonly have a tendency to utilize varied scenarios for imaginative outlets that affords them opportunities to plan, devise, and make fantastic structures (Figure 3), reenactments of renowned film scenes, models, and works of art (Short, 2012).

![Gothic, architecturally-themed structure built in ATI Minecraft class (ATI, 2014).](image)

**Figure 3.** Gothic, architecturally-themed structure built in ATI Minecraft class (ATI, 2014).

**Multiplayer**

Minecraft may be played through a server setup that is hosted by players or run by an outside hosting provider service (Makuch, 2014). This enables multiplayers to work collaboratively and interact within a shared 3-D space (Milton et al., 2014). Server operators have access to server commands such as setting the time of time or teleporting players to various locations (Hill, 2014; Talley, 2014). Hosts may also restrict certain IP addresses or
MinecraftEdu

MinecraftEdu is an educational version of Minecraft made specifically for classroom utilization. It allows the instructor to control the virtual world to teach resource and classroom management (Bristow, 2013). Elliot Bristow, of The Edublogger, stated that MinecraftEdu is an achievable tool for educational systems because it doesn't require top-level equipment to run and offers multiplayer servers set up and managed privately by the instructor (2013). This offers low cost investment in equipment and classroom management for the instructor. The private-server function is important when considering the game’s function as a space for students to work together and be innovative (Schifter & Cipollone, 2013).

Virtual bullying among students is a concern for teachers. When numerous students are gathered inside a virtual space, the possibility of student virtual-bullying is a real possibility (Wingrave, 2011). MinecraftEdu offers teachers the capability to monitor and correct this behavior in real-time (Smeaton, 2014). The game has a user-friendly client interface, which makes it easy for a majority of school-age students to learn, as indicated by research on children’s gaming propensities (Durkin, 2006).

Like the consumer version of Minecraft, MinecraftEdu has several layers of progression, (e.g. mining for resources, avoiding hostile mobs) that can be troublesome for the students to handle on the off chance that this is their first experience with Minecraft (Duncan, 2011). Having them assemble their own materials and instruments would likewise be very time consuming, which is troublesome since it makes investigation of the information significantly
more strenuous and also distracts the students (Smeaton, 2014; Duncan, 2011). To allay these concerns, the students inside this case study were offered access to a restricted supply of assets (e.g., building squares, apparatuses, etc.) and players were in a world controlled by the instructor who used a private server set up singularly with the end goal of the Minecraft class.

Minecraft has numerous indicators of what makes for a positive learning environment: student-originated tasks, profound engagement, exercises that encourage children to continue to achieve higher objectives, energy over what has been taken in or uncovered, apparatuses for composing, and various modes of play that empower children to mold the game to their preferences (Schifter & Cipollone, 2013). Instructors may utilize multiplayer environments that are tailored for their classroom. Using games such as Minecraft throughout the course of instruction is a catalyst for failure. Games are predicated on children repeatedly trying new strategies and coming up short until success is reached (Canossa et al., 2013).

Historical Significance of Video Game Play in the Classroom

While there has been a growing acceptance of video games in education it is important that we step back and look at video game origination and examine how the popularity of video games grew to what is now a multibillion-dollar industry that has effectively created its own subculture (Gee, 2007). In the 1980s, the personal computer began to make its way into households making video games more accessible to consumers (Hassel et al., 2012). Although graphics were not as technically advanced as today the same underlying purpose was shared with games of today; problem solving to reach a particular goal or achievement (Gee, 2010). Titles such as Logo Programming and Lemonade Stand, although peaked in the 1980s, pioneered educational gaming that eventually took hold in the classroom among K-12 students.
These games allowed for personal interaction and engagement throughout the lessons they offered in basic programming to business and economics.

Seymour Papert was quoted as saying video games that teach or edutainment games incite kids to talk about “hard fun” when referencing the games (1998). He further stated that in spite of the games being hard the students find that hard is a direct correlation to fun. The games present challenges that students are more apt to become highly engaged in order to problem solve the challenge set before them (Papert, 1988). Papert, in concert with a team from the MIT laboratory, designed the Logo programming environment with the intended use of teaching students problem solving through programming and mathematics with a computer as a tool. In 1980, Texas Instruments piloted the programs that taught Logo to 450 students (Papert, 1994). At the same time the project was piloted in New York City. Teachers in the schools in both cities were offered extensive training and a summer institute in preparation for the launch of the project (Papert, 1994).

As the popularity of Logo on personal desktop computers descending and MS-DOS gradually took over, new games in the edutainment industry began to evolve (de Aguilera & Mendiz, 2003). With the introduction of Snooper Troops in 1982, students were taught problem solving skills, note taking, and organizational skills by solving mysteries generated by the game (Squire, 2003). Following Snooper Troops, one of the most widely played games of its time, Oregon Trail appeared in the edutainment market (Gee, 2010). Developed by history teachers in the 1970s, Oregon Trail’s crude graphics did not inhibit students from engaging in an adventure of leading settlers along the Oregon Trail by battling raging rivers, dysentery,
snakebites, and broken wagons. Oregon Trail became widely used in classrooms by the 1990s and now has become known as a legacy in the edutainment industry (Brown, 2008).

With the popularity of Oregon Trail in the 1980s, other pc edutainment games began to emerge. Games to teach math, reading, geography, and problem solving skills began to take hold in schools across America. In 1985, World is Carmen Sandiego took students to places around the world showing them places in Europe, United States, and even time travel by making students answer geography questions to solve the mystery of Carmen Sandiego’s whereabouts. Following the success of this game, students in American classrooms began to hone their reading skills with the game Reader Rabbit in 1986 (Online Universities Staff Writers, 2012). Number Munchers and Math Blasters began to arrive in classrooms in 1987 (Online Universities Staff Writers, 2012). No longer were students tasked with learning what may have been conceived as boring subject matter, in a rote memorization sage on the stage, learning environment. Video games had taken hold in classrooms and students began to see learning as fun (Gee, 2010).

Throughout the 1990s more edutainment video games appeared for consumer use and made available to educators as a tool in their classroom. Games in the classroom became more of a norm than an anomaly (Gee, 2007). Students had available to them another avenue besides textbooks, paper, and pencil from which they could draw new knowledge and enrich existing knowledge (Hassell et al., 2012). Now, educational games are not just found on store shelves but the Internet as well. Math Blaster, BrainPop, DuoLingo, FunBrain, and many more have taken hold in classrooms as an extension of learning. Baker, Walonoski, Heffernan, Roll, Corbett, and Koedinger (2008), reported that students were more actively engaged and
exhibited lower frustration levels when utilizing video games for subject matter that they otherwise perceived as boring, such as, reading, math, and geography. Piaget’s theory of play may come in account when supporting this idea of lower frustration levels and higher engagement. In the next section the author will discuss how play is important to learning by illustrating through works of Seymour Papert (1993; 1998; 1999), as well as other authors and researchers.

Gaming in Education

Within the last ten years, educational gaming has evolved to effectively model players perceptions, analyze movements in real-time, and gather data from student-played games and activities. As noted in its report of academic competitiveness, the U.S. Department of Education was quoted as saying that small-scale studies such as this create a:

...critical pathway for the development of successful educational interventions and activities, starting generally with small-scale studies to test new ideas and generate hypotheses, leading to increasingly larger and more rigorous studies to test the effect of a given intervention or activity on a variety of studies and in a variety of settings. (U.S.DoE, 2007, p. 13)

In consideration of game-based learning, the research was examined to determine any relationships among players that may be depicted through their actions, inclinations, impact on singularity, and other scholarship gained through game play.

Schell (2011) suggests that learning exists with reference to the persona category that some of the game players pursue–the player selects a character demeanor within the boundaries of a virtual world associated with the real-life choices and the code of conduct that the player manages. Their avatar choice mimics traits that are most linked to the player’s real-life persona.

Canossa posited that Minecraft has much more management to articulate definite motivations; some of the intentions are far stronger and penetrating in some players than
others (2013). He suggested that this behavior could be explained by the fact that there are

certain types and lifestyles of individuals that choose to play Minecraft (Canossa, 2013).

The simplistic nature of Minecraft may attract curious and crafty players (Schifter &
Cipollone, 2013). It allows players to be creative and resourceful without an abundance of rules
(Peisner, 2014). Minecraft players demonstrate substantial coercion towards inquisitiveness,
economy, autonomy, respect, and optimism, but are unconcerned with recognition or position
(Egenfeldt-Nielsen, 2011). Adequate inquisitiveness, economy, respect, and optimism
demonstrate elevated correspondence with the different facades of motivations while
recognition and position witness a considerably lesser correlation (Vaala, 2014). The one
remaining factor that diverges from the track is control.

Theoretical Framework

Game-based learning is used in an abundance of fields from military training to K-12
classrooms (Gredler, 2004). With that being said it is important that the theoretical frameworks
supporting this style of learning and teaching is examined and applied to support the practice of
using video games as a teaching tool. This section will examine various theories that support
individual aspects of game-based learning as well as work in concert with one another to create
a strong foundational structure supporting GBL as a valid instructional tool of practice in
educating students.

Problem Solving Through Play

Games and learning have been associated with our educational system for a time that
predates digital technology (Kapp, 2012). Johan Huizinga (1971) postulated that play is a
primary and necessary activity across multi-generational cultures. Certain milestones in a child’s
Piaget suggested that a child begins to understand rules from a young age, as Small & Vorgon (2008) noted:

Jean Piaget charted important development points in a human’s life from early childhood to adulthood. Beginning with the first two years of life, when a toddler develops awareness of other people and learns to relate to them. From two to six years, the young child learns basic language skills. However, thinking is relatively concrete until the teen years, when the ability for abstract thought and reason takes hold.

Related to this and long before today’s digital spaces, Mood & Sprecht (1954) posited that gaming and its unmatched advantages in training and those who fail to see gaming for what it is worth often overlook education programs. “A game can easily be made fascinating enough to put over the dullest facts. To sit down and play through a game is to be convinced as by no argument, however, persuasively presented” (Mood & Sprecht, 1955, p. 5).

Creative or imaginative play is a vital segment of a child's typical development and cognitive growth (Bodrova and Leong, 2007). What may appear to be a basic and uncomplicated route for youngsters to beguile themselves is really a complex structure that influences all parts of a youngster's life (Bodrova and Leong, 2007; Bruce 2011). Play shapes how kids understand the world around them, how they learn the skill of thinking, and how they gain dialect (Bodrova and Leong, 2007; Small & Vorgon, 2008).

Seymour Papert, MIT mathematician and inventor of the programming language, Logo, has done much research on children using computers as instruments for learning. His basis is on
the fundamental framework that children should have fun while learning and be able to apply
skills in real time. He is quoted as saying:

Teaching ideas on the premise that a student will need the information one day in the
future is not an effective way for students to learn. Teach ideas that are useful at the time a
student is using them and they are applicable for the student to assimilate the knowledge and
retain it long term. The good way to learn is to use it now (1999).

He further asserted “we learn best by doing” indicating that creating something outside
of ourselves is the best way of learning: a child building a fort with Legos, writing their own
book, building a robot or designing and creating a video game are all examples of constructing
(Papert, 1999). Information is learning and immediately applied in all of these instances.

Bodrova and Leong (2007) posit that when youngsters have discourse with themselves
they participate in inventive play. Pretending in play indicates a child is making a story and
giving a voice to the distinctive characters in the story (Omrod, 2006). At the point when kids
mimic others, they are adding to a vocabulary that permits them to label and explore their
general surroundings (Omrod, 2006). Less verbal youngsters may articulate more during
imaginative play than in different settings (Bodrova and Leong, 2007).

Of Piaget’s four stages of cognitive development, stage four and five are evidenced in
learning in a game based environment (Papert, 1993). During stage three, Concrete Operations,
students have the ability to perform mental operations and understanding their reversibility
(Piaget, 1973). Stage four, Formal Operations, marks the beginning of abstract thought and
deductive reasoning (Piaget, 1973). Through the use of Minecraft, students are planning
strategies, conceptualizing characters, plot, and survival methods, in addition to building worlds
complete with complex structures. This evidences Piaget’s description of the formal operational phase of cognitive development (Piaget & Inhelder, 1969). Seymour Papert’s discussion of constructionism, putting constructivist principles to work in a classroom, illustrates how Minecraft as a teaching tool is rooted Piaget’s constructivist theories of cognitive development (Papert, 1993).

Banks and Potts hold that Minecraft presents a dynamic space for social constructivism “where collaborators demonstrate specific skills but also give players the ability to learn how to learn” (Banks & Potts, 2010, p. 6). Minecraft’s position as a complex framework necessitating the contributing of information, and as an imaginative stage for ingenuity and expression, bring about two primary kinds of social data within 3-D spaces in Minecraft: (1) students seek information from others, and (2) illustrate a sense of pride when sharing their accomplishments with others in the space. The combination of these two types of social data work in concert to form an ecosystem similar to that seen in YouTube, discussion forums, and microblogs (Banks & Potts, 2010; Lastowka, 2012).

Vygotsky ‘s theory of cognitive development postulates that information from the outside world is manifested and morphed through language (Bruce, 2011). Since language is both a way of corresponding to others and a social device used to transmit cultural beliefs and its derivative, play is an essential part of a child’s ability to develop linguistically and comprehend their surroundings (Bodrova and Leong, 2007). Bodrova and Leong suggest that when a youngster is at play, he or she is in a consistent dialog either with self or others (2007).

Children experiment with language and explore different roles through child-centered play. This guides them from regulated external cognition toward regulated internal cognition.
(Bodrova and Leong, 2007; Bruce 2011). Through play, students can gain confidence in their own language use and the ability to manage their thought processes through their own perspective (Papert, 1993).

Bodrova and Leong (2007) stated that when a child is figuring out how to finish an assignment and a more skilled individual gives support, the child then has the capacity to move into another zone of advancement and critical thinking. Vygotsky alludes to this procedure of aid as scaffolding, which helps connect the contrast between a child’s present level of critical thinking and his potential for more complicated critical thinking.

Social Constructionism and Constructivism

Constructivism, according to Papert (1993), is the building or creation of new knowledge. It is the participatory process where learners use prior knowledge to make connections and create their own system of learning (Papert, 1993; Piaget, 1973). Additionally, in constructivism, learners make sense of the new constructs on how they see the world and how it is applicable to their new knowledge through cognitive processes (Papert, 1993; Piaget & Inhelder, 1969). Papert (1993) further posits, once the new knowledge is built then students draw their own conclusions and decide how they will use this new knowledge in their view of the world and how it works. As defined by Seymour Papert (1998), this idea is constructionism. This section will further define these concepts in detail.

In social constructionism, people construct knowledge via renovation and occurrences they usually share (Schwandt, 2008). Social constructionism is divided into two main realms of learning: (1) students create their reality and real-world affairs and, (2) through experiential learning, students act upon these new realities by creating an updated knowledge base of their
perception of the world and its operation (Leeds-Hurwitz, 2009). The social constructionist’s representation illustrates the reality that our everyday occurrences, observations, measures, and proceedings only survive because of these collective progressions. From the perspective of a social constructionist, all acquaintance claims are prearranged within a theoretical framework where the populace gives details and illustrates their terms (Schwandt, 2008). According to Schwandt’s (2008) theory, interaction related to personal experiences between participants yields new insights.

Dewey contended that learning should have importance and significance. For instructors to construct a setting that is conducive for yielding positive learning outcomes, lessons should be associated with the student's outside world and environment so that they can effectively grasp learning objectives (Schifter & Cipollone, 2015). Further, Vygotsky (2005) defined learning as a complicated operation that begins as “social interactions between individuals; gradually acquire meaning and are internalized by the learner.” This kind of cognitive, hypothetical premise could perform in conjunction with a constructivist perspective when students work collectively with each other to bring their own experiences to create the importance of collaboration among the learning group (Baker et al., 2008).

Constructivism is based on students interacting with each other to build new knowledge with a specific end goal in mind (Fosnot, 1996). The educator and content work in concert to afford the student an opportunity from which to frame information into a new construct of knowledge, and can be achieved through asynchronous discussion forums, problem-based activities, collaborative learning activities, and activities centered on the understanding by
design method. Under the constructivist model, students learn through cooperative learning within group settings through interaction with other learners (Papert, 1998).

In certain games that allow for communal playing, GBL players communicate shared goals to acquire new knowledge (Greitzer et al., 2007). Known as social constructivism, this manner of learning encourages students to use their prior experience to create a collaborative base of knowledge from which to assimilate new learning within a community of practice (Kim, 2001; Lave & Wenger, 1991). Game-based learning is a constructivist learning methodology based on multiple theories including located learning, empirical education, and commotion hypothesis (Kim, 2001).

Experiential and Transformational Learning

To afford a more personal and engaging environment, experiential learning may occur at a communal site (Klopfer et al., 2005) such as a classroom. Game-based learning in the classroom allows the players to continually participate and create new experiences in a mature and civilized environment incorporated into a refined setting. Klopfer et al. (2005), further suggested that learners in such an environment exhibit internal motivation to continue the game utilized in this setting.

Participatory culture in GBL offers opportunities for students to engage in experimentation within the context of their community (Barab et al., 2008). In GBL environments, students progressively work in an intuitive, innovative, and communal effort to develop new information. Students involved in game-based learning become “agents of change who use real-world skills” to create new knowledge (Barab et al., 2008).
Transformative learning involves experiencing a deep, structural shift in the basic premises of thought, feelings, and actions. It is a shift of consciousness that dramatically and irreversibly alters our way of being in the world. Such a shift involves understanding of ourselves and our self-locations, our relationships with other humans, and the natural world. (O’Sullivan, 2003, p. 327)

In keeping with this, Baker et al. (2008) suggested that this new knowledge prepares them to interact with others in a 21st century workforce. Figure 3 illustrates the trichotomy of constructivism, experiential learning, and transformation learning related to the student learning experience. The learning methodologies within the confines of GBL are inherent to one another. GBL sustains an environment for students to define and create knowledge in a social environment (Makrakis & Kostoulas-Makrakis, 2012)

*Empirical Education*

Rooted in observational experience, game-based learning will help the experiential learning in a player and enhance the ability to learn every detail by implementing physical and observable activity (Greitzer et al., 2007). This social constructivism experience among users affords students the opportunity to collaborate knowledge and resources to construct dissimilar scholarship of objectives presented at the start of tutelage (Ally, 2005).

Students are experiencing existing knowledge while transforming it into new and applicable knowledge in real time meanwhile connecting with others in a social constructivist setting (Makrakis & Kostoulas-Makrakis, 2012; Papert, 1993; Barab et al., 2008; also see Figure 4).
Figure 4. Trichotomy of learning theory in game-based learning (Makrakis & Kostoulas-Makrakis, 2012).

Commotion Hypothesis and Social Learning Theory

Game-based learning is a modern way to learn and gives players an opportunity to attain communal dealings and associations. A single-player game does not give the student opportunities to interact and refine social skills (Greitzer et al., 2007). In Lave and Wenger’s definition of communities of practice (CoP), members network through a shared domain of interest, engage in a collective learning process, and assess how to improve their learning (1991).

Social learning theory can be closely tied into the realm of social constructivist pedagogy. Badura (1977) maintains that learning is a cognitive process and takes place in a social context, which can include observation or direct interaction with others. Considering the social progressions in the study of game-based learning, Kapp (2012) argues that games provide young minds with a likeness grouping that will work together to face the upcoming hurdles in
the game narrative, which enhances the ability to mingle with peers. In this type of interaction, players tend to employ an urbane way of learning enhanced by interest and excitement of game play.

In social learning theory, GBL affords players opportunities to share more than ideas; they share tactics to manipulate the game play and secure their way through the end of the task given. While doing so, they may share ‘cheat commands’, ‘shortcuts’, and ‘power points’ with the other potential players. Kapp described it as:

...a vigilant yet painstaking submission of game philosophy in creating a solution for the tribulations and to persuade the learning process with the use of all the agreed rudiments of the game are supposed to be suitable (Kapp, 2012, pg.12).

Shaffer (2007) offers comparably states that games tender implicit worlds that act as efficient circumstances for learning. Performing in such worlds permits apprentices to extend social performance and hone in on the uniqueness of a genuine, specialized sub-world. These soft erudition effects can be more tactful and worthy than the traditional brick and mortar method of teaching (Schaffer, 2007).

Game-Based Literacy Learning

Game-based learning (GBL) can be referred to as a learning method that incorporates game attributes with educational curriculum (Belloti et al., 2009). These labor in concert to perform many tasks that, when performed alone, were not achievable (Greitzer et al., 2007). Many games used for GBL were initially very simply designed. Games created for the sole purpose of education and classroom learning strive for dedication of educational intentions and
achievements through design in an effort to maintain creativity and a circumspect attitude of
game play (Gee, 2007).

GBL realizes the understandings of tutoring outside the boundaries of traditional print
and paper education (Papert, 1998). Seymour Papert suggests games play the role of an
educator tool at a different level (1998). Games not only work in single-player mode, but also
multi-player mode, where the players must interact with other players to communicate and
respond to various game modes, play situations, character sound, and character movement
(Jewitt, 2005). Located significances, user communication, and gaming circumstances are the
pathways in which these players interact with modes (Jewitt, 2005). By itself, gaming is a
learning tool that centers many multifaceted relations toward understanding. Squire said:

To be educated in gaming standards signifies that you are able to do various things with
games, as the gaming approach pushes our hypothetical philosophy of learning potential (2008,
pg. 651).

When referring to class education and activities, GBL extends the imaginative
boundaries of various opportunities for students to intermingle in experimental erudition
across the context of the game.

Games and gaming have been core to instructive frameworks for several hundred years
(Prensky, 2006). Computerized games have emerged as an instructive tool in serious gaming
(Knight et al., 2010). Developers of educational games, students in the K-12 and higher
education instructive environments, parents, and governments have adopted educational
gaming with enthusiasm (Krumholz, 2011). This change of mentality has brought about
expanded acknowledgment and mindfulness on the physical, instructive, and mental profits,
and other positive outcomes of gaming regarding advancement of learners in the K-12 and other instructive frameworks (Krumholz, 2011).

Games also offer continuous feedback and formative assessment (Ebberly Center, 2012). In a traditional school model, during summative assessment, information is expelled followed by a unit test to determine the extent of longer-term retention (Ebberly Center, 2012). In the interim, students may be subject to formative assessment via formal or informal testing (Crooks, 2001). Teachers may garner a formative assessment to improve student attainment via computer games (Crooks, 2001).

Implications and Benefits of Educational Games

The characteristics of serious gaming in education make them a vital part of instruction in their intuitive nature (Elliot, 2014). These gaming characteristics provide for goal-driven content tutelage, understanding of rules and adaptation, critical thinking strategies, characteristic incorporation, and how to adjust to diverse circumstances (Elliot, 2014). Gaming encourages learners to appreciate cardinal elements of learning, including contribution, delight, ardor, inspiration, satisfaction of one's self image, innovativeness, and emotional awareness (Krumholz, 2011). Of incredible significance are educational gaming aids to make social connections around K-12 learners (Egenfeldt-Nielsen, 2011). In addition to its physical and psychological ramifications, GBL has organic and evolutionary gains for learners such as connectivity, developments, and brain development (Schell, 2011).

GBL is a vast yet nascent area of research that is coming into its own while evidence of its implications on K-12 learning is manifested (Gee, 2007). For many pupils, digital and non-digital media are intermingled within classroom instruction (Prensky, 2006). GBL is a digital
media technology that converges among learners in a “participatory culture” where learning is
shared with others via video, music, blogs, and 3-D, real-time gaming (Barab et al., 2008).
Jenkins (2009) delineates this as “a culture with relatively low barriers to artistic expression and
civic engagement, strong support for creating and sharing creations, and some type of informal
mentorship whereby experience participants pass along knowledge to novices.” Within this
culture, members often believe that their contributions are of importance to the creation of
knowledge and create a degree of social connection.

Educators turn to technology or computer-driven media through the use of wikis, blogs,
or discussion forums (Schell, 2011). Eschenbrenner, Hui-Hoon Nah, and Siau suggested that 2-D
tools are limited when attempting to achieve these five common goals: engagement,
interaction, collaboration, experimentation, and idea generation (2008). However, the medium
of the 3-D virtual world (3-DVW) has illustrated how providing a shared virtual environment can
better achieve these common goals (Eschenbrenner et al., 2008).

Papert describes game-based learning as a virtual truth or realistic way of learning
within the constructivist framework (1993). Students can be occupied with a simulated
movement and work cohesively in a scattered setting that most nearly recreates the favorable
circumstances of being a 3-DVW (Eschenbrenner et al., 2008). As the standard transformation
in training has grabbed hold of the class objective, there is a requirement for innovation to help
new learning situations. Dewey (2005) recommended that the movement towards engineering
is supportive of Dewey’s hypothesis of constructivism. Barab et al. (2008) additionally places
that on the grounds that virtual situations are becoming progressively intuitive and community-
oriented, innovation should mimic the same pattern as that to develop new information.
Student-created, virtual situations prompt an era of new thoughts, critical thinking, and experimentation. In a case study conducted by Michele Dickey (2005), her work evidenced the realization of collaborative and cooperative learning, and promoted a learning environment that affords students ownership by encouraging a self-defining learning context and interactive experiences that may not be possible within a traditional brick and mortar, face-to-face classroom. In addition, student attrition rates increased when using the 3-DVW environment, as well as providing collaboration opportunities, real-time communication, and visual erudition (Eschenbrenner et al., 2008).

Instructive tools utilizing 3-D, virtual-world situations continue to exhibit popularity and growth through the unique opportunities that these virtual situations can offer (Belloti et al., 2009). These tools provide students opportunities to engage in the classroom and take ownership in their learning, which yields a higher participation rate among students (Eschenbrenner et al., 2008).

A divergence of potentially advantageous results experienced when using 3-DVWs in an instructional setting is referred to below in Figure 5. Elliot (2014) posits that students engaged in technology-driven lessons exhibit a higher engagement and willingness to challenge themselves intrinsically. Elliot further states that gaming in the classroom can assist to rejuvenate a classroom that may need encouragement for learners (2014). Teachers can rewrite formal lessons by integrating a tool with which students are familiar in their daily lives (Elliot, 2014).
In a small case study, conducted by a middle school principal in Eugene, Oregon, students were offered a Minecraft class in concert with core standards (Tromba, 2013). Peter Tromba, district technology coordinator, reported the principal witnessed students who generally saw school as irrelevant and out of touch were more active with the learning environment (2013). He also noted that, because of the private server they were able to establish, teachers could work with the students asynchronously while monitoring behavior within the world and the classroom (Tromba, 2013).

With benefits, there are also implications to utilizing a 3-DVW within curricula. Figure 6 demonstrates unique issues that may arise in the utilization of a 3-DVW in education (Eschenbrenner et al., 2008). These 3-D virtual worlds may pose new opportunities for education. Langdon (2006) states that components considered for instruction open doors, incorporate legitimate preparation and introduction, proper procedures for incorporation, and criteria for deciding value-added exercises.
Digital Presence and Digital Futures

Davidson and Goldberg (2009) claimed “Digital expertise has spectacularly encouraged self-erudition, while web interfaces now opted for far less hierarchical and more horizontal mode of access.” Digital advances have progressively increased social networking, interactive and collaborative writing, and the language we use to communicate messages. The utilization of such digital innovations has mainstreamed into the learning arena. The next optional step is to shift to GBL and make the most of the learning techniques utilized in education settings.

Player Modeling

To research facts and figures used to collect substantial evidence that indicates a distinct relationship between the player and real-life activities, researchers have probed the contrast of player and player modeling (Mahlmann et al., 2010). Out of much research, two eminent reports provide distinct and profound knowledge regarding the field of consideration.
Concerned with the client perspicacity and amusement figure users experience during play, Togelius, Yannakakis, and Karakovskiy, and Shaker (2011) examined three foci of GBL:

- Subjective (a series of random questions)
- Objective (facial expressions, skin conductivity and voice commands)
- Game play-based (in game actions and activity)

In each category, numerous substitutes were programmed, such as whether the dimensions are prearranged according to any model and if the interface agrees with preference or ratings (Togelius et al., 2011).

Smith, Lewis, Hullet, and Sullivan (2011) offered a broad and productive view of player and game modeling; setting aside the resource of information, modeling can be classified into:

- Scope (entity, class, collective, theoretical)
- Purpose (generative and evocative)
- Domain (human proceedings and game responses)

Earlier studies on game-based learning focused on analyzing datasets from games played in a test condition and under lab conditions. Canossa et al. (2013) have proposed the idea of using self-organizing maps for the identification of player types among other players stances engaged in such games as Tomb Raider: Underworld. In a subsequent study, players’ actions, activities, and behaviors were predicted in the Tomb Raider game by examining at what level the user stops playing through analysis of the initial behavior of the user (Mahlmann et al., 2010).

**Conceptual Framework**

Investigation on videogames disclosed that users are occupied in a diversity of communications or an assemblage of literacy (Steinkuehler, 2007). Youth productively look for
and interpret game-based content that necessitates vocabulary and interpretation ability. Proceedings that recurrently connect in-game comprehension and school-based cognition will reach a new level of understanding (Steinkuehler, 2007). It is from this evidence that this case study will examine whether or not students can acquire new knowledge using 3-DVW spaces in a classroom setting with predefined teaching/learning objectives.

Similarly, those who take an interest in games illustrate numerous abilities to comprehend and/or advance their game play (Prensky, 2006). Canossa et al. (2013) advocated that gaming, like literary understanding, is not an introverted act in an introverted environment. There has also been found a relation between on-screen and off-screen personified education, signifying that game play can create a difference in off-screen procedures and perceptions (Gerber, Abrams, Onwuegbuzle & Benge, 2014). Alternatively, the social and cultural events and exchanges stimulate and notify game assembly (Gerber, Abrams, Onwuegbuzle & Benge, 2014).

Gaps in the Utilization of 3-DVWs

Building upon the foundations of Bloom’s Taxonomy, Fink’s Taxonomy model surpasses Bloom’s by broadening educational objectives (see Figure 7) (Fink, 2003). Most of the categories in Fink’s Taxonomy fall within the confines of utilizing 3-D virtual worlds in an educational setting. “The power of instruction is seldom of much efficacy except in those happy dispositions where it is almost superfluous” Gibbon, quoted in Feynman (1964).

Collaborative workgroups, interactive and cooperative activities, and students who bring forth prior knowledge to add to the group’s quest toward gaining new knowledge are all evidenced in Fink’s categories.
Figure 7. Fink’s versus Bloom’s Taxonomy visual comparisons (Eschenbrenner et al., 2008).
According to Fink (2003), for teachers to reach a level of higher-level learning among students, they must transform their role from presenter of information to facilitator.

To advance in the game, players must use problem-solving skills to create another framework of understanding. Most specialists conceptualize learning as multi-dimensional constructs of student abilities. Cognitive learning conclusions, for example, are procedural, revelatory, disposition, and key information (Fink, 2003). The game-based learning model is effectively utilized as a part of some regions of formal training. Figure six compares differences and similarities to both learning models.

Summary

Instructors should consider specific pedagogical objectives they wish to achieve prior to implementing curriculum using 3-DVW as a tool (Eschenbrenner et al., 2008). Eschenbrenner et al. further suggest that value must be assessed throughout disciplinary measurements (2008). Papert (1993) posits the computer presence can modify the classroom environment. Papert’s insistence on focusing on epistemology and a foundational theory of learning as the focal point for educational reform makes his perspective valuable (Davidson & Goldberg 2009). However, for Papert’s idea of educational reform to come to fruition, a change in thinking by educators, politicians, and parents must take hold (Gee, 2007).

This case study determined the benefits and implications of learning through three-dimensional virtual worlds were evidenced during the lessons. Gaps in using 3-DVW learning environments are examined in order to provide groundwork for future studies.

In this section we examined theoretical frameworks to support the idea of game-based learning and utilizing video games with a 3-D virtual environment as a tool for instruction.
Several similar theories worked in concert to provide sustenance to the ideas that make game-based learning a viable option for the classrooms of today. In the next chapter the methodologies for which the case study utilized will be discussed.
CHAPTER 3
METHODOLOGY

Methodological Overview

This chapter reviews the methods used to collect and analyze data. The research utilized archival data generated by Arts and Technology Institute (ATI). ATI shared all surveys, recorded participant interactions, and other data such as physical deliverables from the course of instruction by the students. The data was analyzed using non-positivistic methods that triangulated the data, which was then peer debriefed. This chapter explains the research questions examined and how validity, rigor, credibility, and transferability of the study occurred.

Research Questions

The main research question examined in this research was: Can the use of 3D spaces evoke other knowledge by using tools such as Minecraft?

Three sub-questions were examined that looked into: effectiveness, self-efficacy, and community of practice.

Effectiveness: Is Minecraft an effective tool to acquire other knowledge when teaching predefined objectives?

“Learning” means acquiring skills and abilities as taught by something or someone (Merriam-Webster, 2015). Learning can occur through experience, traditional study skills, or observation. Learners require compelling, intelligent encounters that persuade and effectively captivate them into the learning procedure (Ambrose, 1999). Game-based learning applications can elicit users into virtual circumstances that look and feel organic and significant in nature. As indicated by Dr. Susan Ambrose (1999), executive of Carnegie Mellon’s Eberly Center for
Teaching Excellence, “this is motivational on the grounds that we can rapidly see and comprehend the association between the learning knowledge and our genuine work.”

This question examined to what extent if any new knowledge was gained by students as they used Minecraft as the primary learning tool in a game-based learning environment while studying a predefined objective: architecture types. The author examined pre and post test results to determine growth as well as student created deliverables such as blogs containing student daily reflections, 3-D printed structures that were built and printed by students enrolled in the class as well as video snippets of a virtual tour through the student created structures within the game.

Self-Efficacy: How is a students’ self-efficacy affected when utilizing game-based learning such as Minecraft?

Self-efficacy is the degree or quality of one's faith in one's capacity to finish undertakings and achieve objectives (Ormrod, 2006). To examine students’ self-efficacy and how it was affected during the game-based lessons video and corresponding transcripts were analyzed using the Classroom Observation Code instrument of coding (Abikoff & Gittelman, 1985) as well as Bandura’s Guide for Constructing Self-Efficacy Scales (2006). Since the author was not present at the time of filming a pure ethnographic coding method was not employed but instead modified to examine the archival video data supplied by ATI. In addition student blog comments were taken into account when determining self-efficacy among learners and how game-based learning affected this concept.

Community of Practice: What kind of social engagements provide opportunity for acquiring knowledge by utilizing 3-DVW such as Minecraft?
In determining which coding method would be used to determine social interaction a comprehensive search of databases on Google Scholar as well as the University of North Texas library was initiated by the author. Behavioral Observation of Students in Schools (Shapiro, 2004) and Direct Observation Form (Achenbach, 1986) instruments were utilized in creating a dichotomist type instrument that best suited the type of classroom structure that ATI offered.

Research Setting

The research was conducted at the main campus of Arts and Technology Institute (ATI) in North Texas. ATI’s president is stated as Owner throughout the study. The primary instructor interviewed is named as Instructor in the study. The President of ATI and primary instructor in charge of the Minecraft driven courses and their curriculum were interviewed regarding class structure, information about ATI as a company, and data clarification.

Arts and Technology Institute (ATI)

ATI holds classes during the summer as summer camp courses to introduce students to material that is taught in depth during the school year. ATI is set inside a 4200 square foot retail space housing four classrooms, a special effects room for sound design and green screen video effects, and two all purpose rooms. All-purpose rooms are used for general collaborative meeting space as well as eating and game areas. The space is designed to create an open atmosphere with industrial finish ceilings and brightly painted yellow and green accent walls. ATI has available four video game consoles, a foosball table, and various board games for student utilization during class time breaks. (Owner, 2015).

Students enrolled in camps at ATI are on a schedule that coincides with Texas Department of Family Protective Services minimum standards manual (2015). ATI is a state
licensed facility and is subject to unscheduled state inspections (2015). The ATI daily camp schedule includes warm-up time and general safety announcements followed by class time, snack break, more class time, concluding with daily blog entries by teachers and students then game time (Owner, 2015). According to ATI’s website, class sizes are capped at 1:5 ratios with one instructor or assistant per 5 students. Classroom cumulative sizes are average size of 10 students with five minimum and fifteen maximum students per class (www.myati.org, 2015).

ATI offers courses throughout the school year in addition to summer camp courses (www.myati.org, 2015). Courses include robotics, game design, digital imaging and graphic design, 2-D animation, 3-D animation, 3-D modeling, apps design, programming, and computer literacy courses. In addition to offering courses through ATI, their services are solicited by private, public, and charter schools in the North Texas area (Owner, 2015). Currently ATI serves seven private schools with in-school technology for credit course programs and two public schools with after school programs (Owner, 2015). ATI courses are designed by the owners and instructors in concert to incorporate project-based learning in a holistic environment (Owner, 2015).

ATI Minecraft Instruction

The instructor of the Minecraft driven classes employed MinecraftEdu to control student resources, monitor behavior within the 3-D space, and guide students when needed. One to two instructors and an assistant instructor when required were present to conduct the class. Classes were three hours long in either morning or afternoon sessions. Each class is a total of 15 hours of instruction (Instructor, 2014).
During the camp some students, with the guidance of the instructor’s assistant, printed one copy of their structures for each of the team members utilizing ATIs 3-D printer. Each print took approximately three hours to complete. The team printed the first copy and the instructor printed the following two prints overnight for the students to take home at the conclusion of the week. The printer was set at a medium resolution to save time and materials. Within the settings, structure supports were built into the print requirements to support portions of the building that jutted out—such as the turrets on the castle—to avoid cratering of the heated, soft, ABS filament until it was hardened. This process was “other knowledge” that students acquired in addition to the preset course objectives of architecture taught during class time.

Students

According to the Instructor, 180 participants ages 9-12 enrolled in programs at ATI (2014). Participants were enrolled in ATI summer camp courses. As participants were not required to have prior experience with Minecraft to enroll in the course, experience levels of participants varied (Instructor, 2014). After elimination of students that did not complete the course for reasons unknown to the author and incomplete pre and post-tests for some classes due to time limitations, the number of valid participants was narrowed to 59. The 59 participants ranged in age from eight to twelve years old with an average age of 10 years old; 92% male and 8% female (Figures 8 and 9). Participants were not identified to the author in any way other than by color of shirt or the identifiers “T” and “student” within the video transcripts.
Student experience levels varied. Most had prior experience with Minecraft but no experience was necessary to enroll in the class (Figure 10). A brief survey was given to the students to determine their experience and background with the use of Minecraft. Question 1 asked if students had taken a Minecraft camp before this week. The responses were that 17.5% said yes and 82.35% said no.
Figure 10. Have you taken a Minecraft class before this week? (ATI, 2014).

Question 2 asked how many hours did the student spend playing Minecraft in a typical week? When polled, 33.9% of the students reported spending two to three hours per week playing Minecraft (Figure 11). The number of students who spent zero to one hour per week was 30.51% and students who played four or more hours per week totaled 36%: 4-5 hours = 17%, 6-7 hours = 12%, more than 7 = 7%.

Figure 11. How many hours do you spend playing Minecraft? ATI, 2014).
ATI Instructors

Instructors are graduates with digital technology (3-D modeling, game design, animation, movie making, and digital artistry) or computer science (language programming, apps development, and network design) backgrounds (www.myati.org, 2015). ATI has shared archival data in forms such as student-created blogs, video/video transcripts, pre-/post-tests, demographic surveys, images of worlds built by students, and physical 3-D prints extracted from the 3-DVW created in Minecraft by the students from Minecraft Summer Camps.

In the ATI Minecraft classroom, two instructors were connected via laptop computer to a private server, which they set up to conduct the class in a private setting. Instructors are at the front of the room with a projector screen mounted behind them for instructional purposes. Instructors self-identified themselves as lead instructor or co-lead instructor for each class session.

Classroom

The class size was 12-16 students but varied per week by enrollment. Both instructors and the assistant were male. Classroom sizes were 12x20 feet and desks were placed in a u-shaped configuration to afford the instructors and assistants the ability to maneuver about the classroom unobstructed. To maintain transparency among participants, instructors were labeled as “T1” and “T2” throughout the transcript and students were labeled as “student” or identified with a color or pattern of shirt they were wearing.

The students were seated at tables and each was assigned a laptop. Students faced inward with their backs to the walls (Figure 12). This configuration allowed one instructor to actively monitor in the classroom while another instructor actively monitored asynchronously.
through the virtual world. A teaching assistant was also present in the room. The role of the teaching assistant was to physically roam about the room to address the needs of students; for example, help them troubleshoot and teach them to navigate the software.

Although students had the ability to chat online with one another, they chose to speak out loud and at times even physically walk to another computer to investigate the work of others within the learning community. Students were surveyed at the beginning of each week regarding their demographics, experience with Minecraft, and time spent playing games (including Minecraft). Surveys indicated that classes were primarily comprised of male participants and many had prior experience playing Minecraft for personal use.

All instructors were well versed in the game, Minecraft. They set up private servers for each class so that the students worked in a secure environment. Arts and Technology Institute
employs instructors for the purpose of year-round teaching. Instructors also have a minimum of a bachelor of arts and science in arts and technology.

Methods and Procedures for Data Generation, Collection, and Analysis

Research for the study was done in 4 stages. The first and second stage being done by ATI staff prior to this study and is archival in nature. ATI staff with the exception of the analysis portion primarily did the third stage. The author, being that the study utilized raw archival data, conducted the fourth stage. During this stage the author based on criteria that are discussed in Stage 4 narrowed participants.

Stage 1: Existing ATI Archival Data

All data was generated and collected by ATI and shared with the author and UNT Department of Learning Technologies for the purposes of inquiry and growth in the field of learning technologies. ATI utilizes this data primarily for its own personal business analyses and growth (Instructor, 2014).

During the enrollment process for ATI, parents give their consent to ATI to obtain information through media, surveys, benchmark assessments, etc. (Instructor, 2014). Benchmark assessments were in the form of pre and post-quiz multiple-choice assessments. The instructors prior to the start of summer created these assessments. The data used by the author was archival data shared by Arts and Technology Institute.

ATI owner and instructor interviews were conducted to gain better understanding on the setup of the classroom and how the lessons were constructed. A modified version of ethnographic observation was utilizing by examining videos and their corresponding transcripts. Hahn’s (2008) model of qualitative coding was utilized when coding video transcripts to mine
for data among verbal and non-verbal interactions of the students and instructors (Figure 10). Further student performance and social interactions as well as student created deliverables as evidence of assessment were analyzed to determine outcomes.

At the beginning of each week, in addition to the demographic and experience survey, instructors administered a pre-test comprised of 15 multiple-choice questions to determine subject knowledge prior to beginning the course. The questions included matching pictures to terms, basic history of architectural origins, and questions regarding specific building features. A multiple choice post-test was administered online at the conclusion of the week to measure acquired knowledge. The tests were created through www.quia.com, an on-line assessment subscription-based service, and administered to each child via computer.

The tests measured each students knowledge of basic architectural types: Roman/Greek, Medieval, and Post-Modernism. Students were asked to identify portions of buildings such as dome versus arch, nave, transept, flying buttresses, and more (Figure 10, also see Appendix A). They were also asked to identify buildings that were built in specified styles.

Stage 2: Instruments and Surveys

To gain an understanding of data and report on the perceptions, learning outcomes, and interactions of the participants, a triangular, mixed-method design was employed for this research project. Quantitative measures were placed when reviewing demographic information and experience levels of enrolled participants as well as benchmark exams to determine growth (Figure 13).
Figure 13. Example #1 question from assessment given to students enrolled in Minecraft courses (Arts and Technology Institute, 2014).

A survey, created by ATI’s owner, to determine demographics and experience levels (see Appendix H) of students was put in place and administered by ATI instructors during the first day of each session. This survey was computer based and created utilizing Survey Monkey, a free web-based survey creation instrument. ATI staff deleted incomplete surveys. Subjects, whom did not complete the survey, were deleted from the data.

Prior to the start of the summer sessions, ATI instructors created pre-test and post-test benchmarks. This instrument was created to determine nominal growth in learning outcomes. Benchmarks assessed knowledge of architecture concepts taught during the sessions. Students that did not complete the assessment were eliminated from the data. This was an additional step in the narrowing process of subjects during the sampling process. This is discussed further in the Interviews and Sampling Stage 4 section. Growth percentages were calculated using the Simple Growth Model. According to Hull (2007) of the Center for Public education, simple growth models record change in the scores of individual students assessed before and after instruction.
ATI created a blog that was utilized by instructors, students and parents as a line of communication among all 3 groups. Transcripts of blog entries spanned 10 weeks of daily entries. Entries were labeled with first name and age before each comment containing student daily reflections. With the assistance of an ATI staff member the blog entries were narrow to the 59 qualifying participants. Transcripts were coded and analyzed by the author. Coding of blog transcripts were conducted by examining text to determine if the discourse that fit into any of the themes or if new themes emerged from the data.

Prior to the start of each class, instructors posted daily objectives describing the lesson objectives that were taught each day. During the last 30 minutes of class, the instructors and students worked simultaneously to post comments about what they liked and what they learned. Photos of students working and student created structures via screen shots were also included in each daily blog. Once per week, the instructor posted a narrated video of the students completed work that included a tour of villages or city buildings exterior, interior and purpose of the structures. Students and the instructor to describe what the viewer was seeing did narration.

Stage 3: Video and Transcripts

During each Minecraft class the ATI Instructor set up 4 video cameras around the room. One camera was set in the front, one on each side, and one at the back of the room. In order to obtain clear audible sound, Camera 1 located at the front of the room was a Cannon XA10 Professional Camcorder. The remaining three cameras were consumer grade and sound at times was not as clear, yet still audible during transcription. Camera 2 was set up on the
instructor’s left side of the room and camera 3 to instructor’s right side of the room. The remaining camera, 4, was set up at the back of the room facing the front of the room.

Prior to the start of each class the instructor began recording. The recordings from cameras located at the front and back of the room showed students entering the room, social interactions, conversations among all participants (instructors and students), classroom management techniques utilized by instructors, peer management techniques among students, and gaming interaction. The cameras located at the sides of the room were primarily composed to show screen activity of students. During class breaks the cameras located on the side of the room would be relocated to show different screens of students. Four separate videos of each class were taken simultaneously for each session to capture various vantage points of the class.

At the conclusion of each session the video recorded by the ATI instructor was given to an ATI staff member for transcription. The staff member utilized the video recorded from the front of the room as the main source of discourse and interaction of students and instructors. One transcript was typed for this video. For the remaining three videos repetitive movements or discourse were not typed but instead mentioned and referred to the first video for detail. Transcripts were given a uniform naming convention of “week of (month, date)_camera 1”. Transcripts were then cataloged and stored on a server for future analytics. A copy of video and their corresponding transcripts were given to the author for research purposes via an external hard drive. Over 150 hours of video was recorded and classes that contained participants were transcribed to total 62.5 hours of video with corresponding transcripts.

Pre-test and Post-test benchmark information was narrowed to calculate only the qualifying members. Incomplete benchmark exams or exams of students that didn’t complete
the course were the first to be excluded from the analysis process. Other exams excluded were based on criteria that disqualified participants for the study (see stage 4) such as lack of parental permission or incomplete work in other areas. To preserve anonymity of participants no last names, gender, or age were given. For the purposes of this study age and gender were not taken into consideration in determining if the use of 3D spaces would evoke other knowledge by using tools such as Minecraft.

According to Instructor, there were additional classes offered by ATI that utilized Minecraft as a tool to teach circuits and city zoning but these classes were not videoed for the author to review (2014). It was reported by ATI that the structure of these classes were similar to that of the architecture-themed Minecraft classes but focused on different learning objectives.

The author examined the staff-transcribed videography and assessed ATI staff-recorded video in order to review student interaction and reaction in various scenarios and dynamics and to analyze students’ actions and reactions during the use of Minecraft as a tool. The author analyzed ATI benchmarks, surveys, and created works and called upon instructors of ATI who conducted the courses to verify the analyzed data and verify the integrity of the report.

Stage 4: Interviews and Sampling

Semi-structured interviews were conducted by the author (see Appendix B) with the head instructor of ATI Minecraft classes as well as the President/Owner of ATI to gain better understanding of course design, daily schedule, and learn about ATI and its company structure. During the interviews, a description of the class structure, objectives, and company structure was disclosed to the author to achieve a better understanding of the background from which
the classes stemmed. No student interviews were conducted during the course of the research by the author.

A purposeful sampling was utilized for the recruitment of participants for this study. Subjects in the study were garnered from archival data generated from a technology instructional facility (ATI) for students of K-12 age range (Instructor, 2014). These students were enrolled in the facility’s Minecraft classes. Arts and Technology Institute (ATI) recruited participants during the summer enrollment process (Instructor, 2014).

Samplings of students were based on specific courses in which students were in enrolled. ATI offers several other courses in addition to Minecraft based courses. For the purposes of this research, the author used only data garnered from students enrolled in Minecraft classes. As mentioned previously, students were not required to have experience playing the game of Minecraft to enroll in the courses.

During the analysis process the number of students analyzed were narrowed from 180 to 59 students. Students were omitted from the data for the following reasons: 1) Enrolled in the class but did not show for any period of time during the scheduled session; 2) Enrolled in the class but failed to come to class for any period of time during the scheduled session; 3) Did not complete the demographic survey; 4) Did not complete either the pre-test or post-test benchmark exam; 5) ATI unable to garner parent consent for participation of student to be videoed or photographed. Age was not a factor in discriminating participants analyzed during the research.

Remaining Participants

Of the 59 remaining students, all students were analyzed during the research process.
Students were in mixed age and mixed gender classrooms and worked cooperatively during lessons. Age, gender, or experience levels when selecting groups to work on projects cooperatively was not a factor in during the grouping process. Students in the Minecraft classes primarily utilized self-selected methods to create their teams. Although projects were completed primarily in a collaborative fashion, demographic data surveys, and pre/post-test benchmarks, and blog entries were completed independently.

Coding and Themes of Analysis

The process of open coding begins with reading through the data several times in search of relationships and themes (Creswell & Clark, 2011). Once these relationships and themes are identified the data is narrowed into a more “usable” format for analysis (Guba & Lincoln, 1994). Initial analysis began with open coding of interactions, which were further analyzed through axial coding, then selective coding.

Open coding is the coding of data line by line into codes that the researcher deems valuable (Creswell & Clark, 2011). This stage of coding is quite subjective depending on any bias or prior experience the researcher may have (Hahn, 2008). Open coding was used to determine themes throughout the text and a modified version of ethnographic observation while watching videos of the students in their class.

Axial coding is the step during coding where original codes are combined into major categories and subcategories are defined in addition to their relation to the major categories (Hahn, 2008). This was used to determine the relationship of the three key themes to the primary research question of the study.

Two instruments were used to create a dichotomy type instrument that best suited the
research for this case study; Behavioral Observation of Students in Schools (BOSS) (Shapiro, 2004) and Direct Observation Form (DOF) (Achenbach, 1986). This modified instrument examined the themes of effectiveness and community of practice. The Behavioral Observation of Students in Schools (BOSS) instrument is an observational tool that breaks down student behavior into five categories (Table 1) (Steiner et al., 2013). Steiner describes the instrument as

The BOSS defines classroom engagement as the desired behavior, represented by on-task active (AET) and on-task passive (PET) behaviors. Impulsivity and hyperactivity are measured by off-task motor (OFT-M) and verbal (OFT-V) behaviors, while inattention is quantified by the frequency of off-task passive (OFT-P) behaviors (2012).

Table 1

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Behavior</strong></td>
<td></td>
</tr>
<tr>
<td>Active engaged time (AET)</td>
<td>Student is on task and actively attending to assigned work, e.g., raising hand, writing, reading aloud, or talking to a peer about the assigned material.</td>
</tr>
<tr>
<td>Passive engaged time (PET)</td>
<td>Student is quietly working on assignment, e.g., listening to a lecture or peer respond to a question, reading at an assigned worksheet, or quietly reading assignments.</td>
</tr>
<tr>
<td>Off-task motor (OFT-M)</td>
<td>Student is engaged in physical activity not directly associated with assignment e.g., engaging in any out-of-seat behavior (defined as buttocks not in contact with the seat), manipulating objects not related to the academic task (e.g., playing with a paper clip, throwing paper, twirling a pencil, folding paper), or drawing or writing that is not related to the assignment.</td>
</tr>
<tr>
<td>Off-task verbal (OFT-V)</td>
<td>Speaking or making any noise not permitted or related to the assigned task, e.g., such as whistling, humming, forced burping, calling out answers to academic problems when the teacher has not specifically asked for an answer, or talking to another student about an assigned academic task when such talking is prohibited by the teacher.</td>
</tr>
<tr>
<td>Off-task passive (OFT-P)</td>
<td>Student is passively not engaged with an assigned academic activity for at least 3 consecutive seconds., e.g., sitting quietly in an unassigned activity, looking around the room, or staring out the window.</td>
</tr>
<tr>
<td><strong>Classroom settings</strong></td>
<td></td>
</tr>
<tr>
<td>Independent seatwork: Teacher present (ISW:TPsnt)</td>
<td>Target child is doing work by him/herself. The teacher is either doing work individually at a desk or rotating around the classroom.</td>
</tr>
<tr>
<td>Independent seatwork: Teacher small group (ISW:TSmGp)</td>
<td>Target child is doing work by him/herself. The teacher is working with children in a small group (eight children or fewer).</td>
</tr>
<tr>
<td>Small group: Teacher present (SmGp:TPsnt)</td>
<td>Target child is doing work in a small group (eight children or fewer). The teacher or an assistant teacher may be working with the group or just be present in the classroom.</td>
</tr>
<tr>
<td>Large group: Teacher present (LgGp:TPsnt)</td>
<td>Target child is doing work in a large group (i.e., whole classroom or a group with nine or more children). The teacher is present in the room instructing the class.</td>
</tr>
</tbody>
</table>
Portions of the Direct Observation Form (DOF) were adopted in creating an instrument to determine engagement and social interaction among students. Created by Thomas Achenbach, The DOF is an instrument designed to provide standardized descriptions of an individual’s behavior and functions. Table 2 illustrates a sample portion of DOF in its original format. The dichotomy of BOSS and DOF used in this research is tailored to the research in this case study and was created by the author. The dichotomous for is entitled Blended Classroom Observation Form (BCOF: also see Appendix E).

Table 2

Sample Checklist for Coding Child Behavior Utilizing the DOF Instrument (Achenbach, 1986)

<table>
<thead>
<tr>
<th>Behavior</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fidgeting in seat</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>Getting out of seat</td>
<td>✓</td>
</tr>
<tr>
<td>Running around classroom</td>
<td>✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>Interrupting others</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>Physical aggression toward peers</td>
<td>✓</td>
</tr>
<tr>
<td>Physical aggression toward teacher</td>
<td></td>
</tr>
<tr>
<td>Physical aggression toward peers</td>
<td>✓</td>
</tr>
<tr>
<td>Physical aggression toward teacher</td>
<td></td>
</tr>
</tbody>
</table>

were used as a template to create an instrument that suited this study. This instrument, Classroom Self-Efficacy Observation Form blended formats and indices in addition to emergent indicators from the data (See Appendix F). Used to code transcripts, the instrument uses a check-mark system to identify behaviors among students.

During the selective coding step in the grounded theory approach, relationships among codes and categories are established. Selective coding was used to locate identifiers among the data. Key themes were identified prior to analytics. Within the themes identifiers were put in place to use when coding student discourse and interactions. These included:

Theme 1: Effectiveness

- Student exhibition of exploration
- Student exhibition of completed structures
- Student and teacher play
- Student displays evidence of knowledge
- Learner-paced acquisition of knowledge
- Students actively engaged
- Teacher immediate feedback
- Students show intrinsic motivation

- Student exhibition of Flow
- Student exhibition of trial and error
- Students build with intrinsic motivation to complete
- Student displays evidence of inquiry
- Students transfer knowledge to outside instances
- Students on task
- Students actively process educational content
- Creativity fostered and exhibited
Theme 2: Self-Efficacy

- Student executes inquiry to other structures
- Student suggests to others additional competition for best structure
- Student exhibits a show of success from their build
- Student asks for others to visit their structure in effort to show success
- Students exhibit control of one’s environment

Theme 3: Community of Practice

- Students and teachers interact to build a community within a 3D space
- Students are quite loquacious among one another and teacher
- Students work together to achieve a common goal
- Students acknowledge others achievements
- Students freely share ideas and opinions with each other and teacher
- Students address shared problems

Interactions of participants were then coded using constant comparison to identify any significant patterns that may answer research questions with key words, also known as the in vivo method. Figure 14 illustrates Hahn’s visual representation of qualitative coding in a systematic breakdown for coding procedures. It begins with a broad idea and narrows to specific ideas.
Figure 14. Hahn’s qualitative coding breakdown/description diagram. (Hahn, 2008).

Validity, Rigor, Credibility, and Transferability

Researchers need alternative models appropriate to qualitative designs to ensure rigor without sacrificing the relevance of their research (Hahn, 2008). Guba and Lincoln’s (1994) model describes four general criteria for evaluation of research: truth (credibility), applicability (transferability), consistency (dependability), and neutrality (confirmability). These criteria must be met in order to establish validity, rigor, and trust in the research study.

Rigor and validity reduce the potential of bias in the study. Rigor is enforcing strict accuracy to detail and discipline to ensure accurate research representation (University of North Carolina Chapel Hill School of Nursing, n.d.). To have rigor in research, the conclusions drawn should be trustworthy. To have a trustworthy research, four criteria should be considered: credibility, dependability, transferability and confirmability, which are addressed below. Validity is an indication of how sound the research is (Validity, n.d.). Two potential types
of validity are internal validity and external validity (Validity, n.d.). Internal validity of this study may affect participants analyzed via video recordings from ATI by researchers who were not there to personally determine true emotion of the setting.

External validity is defined as being able to generalize the findings (Losh, 2013) of this research for all K-12 students. The size of the research population affected the ability to generalize the results of the study, since the research participants are from a small technology facility in North Texas; hence, the non-positivist standpoint taken for this research. Extraneous variables are undesirable segments of the study that influence other variables in the research. A potential extraneous variable is the participants’ perception (like or dislike) of their peers in the classroom that may determine how they feel about their Minecraft class.

Credibility for this study was achieved by employing validation strategies of triangulation, researcher reflexivity, thick, rich description, and peer debriefing. The data was triangulated with the various forms of archival data that were collected from ATI prior to this study (e.g., survey results, student blogs, and video transcripts). Presenting the participants’ voices and providing detailed description of transcript setting, student voices, and survey data achieve thick, rich description. Finally, the author required the assistance of peer debriefers who are familiar with qualitative data analysis and agreed to serve in this role for duration of the study.

Transferability occurs when researchers note specifics of any research situation and compare them to the specifics of an environment or situation with which they are familiar (Guba & Lincoln, 1994). If the description is thick and rich enough for the reader to assimilate the information to such an environment or situation, they will “transfer” the results of said
study to another context. This new context is created to understand the information and create a relevant framework in which they can understand the knowledge, which allows inference to personal situations (Creswell & Clark, 2011).

Reliability and Dependability

Reliability is the extent to which results are consistent over time (Bashir, Afzal and Azeem, 2008). Each participant was given the same survey, class structure, blog template, and expected objectives for the day. From a non-positivist point of view, if this study were repeated with the same participants we would expect the results to be different because the participants will have had a second chance to analyze the questions, their situations may have changed the second time around, and their current mental and emotional state could affect the results. To address dependability, the research methods and processes such as how data is gathered and recorded were made transparent. All data was gathered from ATI and given to the author for the purposes of this study.

Confirmability

In the interest of obtaining true objectivity, researchers have an understanding that it is often difficult to employ data collection methodologies that are not subject to bias (Guba and Lincoln, 1994). Confirmability is a measure of how well the inquiry’s findings are supported by the data collected (Cresswell & Clark, 2011). Through detailed description of the generation of the study, data collection, clear descriptive analytics procedures, and reporting in the conclusion, the author’s perspective, position, beliefs, and confirmability will attempt to be established. In addition, examination of literature published prior to the study was reported to confirm and support findings.
Authenticity

Authenticity is how worthwhile the potential impact of the research will be on the research community or culture (James, 2008). It focuses on the degree to which participants’ experiences are described (Edmunds and Scudder, 2009). To ensure authentic results, participants’ interactions were recorded by ATI instructors and transcribed by other ATI staff. The author received the transcription and video to analyze and return to ATI staff members to validate correct outcomes (member checking). This resulted in a more authentic research study.

Data was coded by performing a grounded theory approach to data analysis. Robson (1993) suggests that in order to provide thick, rich description, ethnographic observation should be used during the research process. Due to the nature of archival data as the base from which our analysis was drawn, pure ethnographic observation was not utilized but instead a modified form was undertaken where the author studied the videos and transcripts to analyze behavioral patterns and interactions of the participants.

Conclusion

In this chapter the purpose of the study and the methodology utilized for data analysis was established. This study was designed to determine if knowledge acquisition is possible through problem-based learning when engaged in playing Minecraft. The following chapter will present the data analysis and results.
CHAPTER 4

ANALYSIS

The research findings reported are based on analysis of the following data sources described in Chapter 3: video, transcripts, blogs, pre-/post-tests, tangible deliverables, and demographic surveys

Analysis of Instruments and Surveys

Analyzing the data from the instruments of interaction, experience levels survey, and completed projects, multiples themes were applicable to knowledge acquisition as referenced in the research question. The data areas reported are derived from surveys to indicate experience levels with the tool Minecraft as well as pre and post-test data to show growth, if any.

On the basic demographic and experience survey, question 3 surveyed students on their personal gaming preferences (Figure 15). Most students (52.54%) reported that they play other games at home but Minecraft is the one they spend the most time playing. Only 1.69% of the students reported that the Minecraft class they were enrolled in at Arts and Technology Institute was their first time to play.
Figure 15. Gaming preferences: Minecraft & other games? (Arts and Technology Institute, 2014).

During the pre-test, assessment of student data resulted in a mean score of 40.1%. The high score was 100% and the median score was 40% (Figure 16), which illustrates that students had little to no knowledge of the predetermined subject matter at the beginning of the course.

<table>
<thead>
<tr>
<th>Points Possible</th>
<th>Low Score</th>
<th>High Score</th>
<th>Mean</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>0 (0%)</td>
<td>15 (100%)</td>
<td>6.014  (40.1%)</td>
<td>6 (40%)</td>
</tr>
</tbody>
</table>

Figure 16. Pre-test-architecture knowledge (Arts and Technology Institute, 2014).

The post-test was administered after approximately 15 hours of instruction; scores showed an improvement of 25.3% on average (Figure 17). The high score dropped; however, the median score improved almost 27%. Overall, these scores exhibit a gain in knowledge from the inception of the course to the conclusion of the course.
Table 1. Scores of Architecture Knowledge

<table>
<thead>
<tr>
<th>Points Possible</th>
<th>Low Score</th>
<th>High Score</th>
<th>Mean</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>5 (33.3%)</td>
<td>13 (86.7%)</td>
<td>9.8 (65.3%)</td>
<td>10 (66.7%)</td>
</tr>
</tbody>
</table>

*Figure 17. Post-test architecture knowledge (Arts and Technology Institute, 2014).*

**Analysis of Transcripts and Videos**

The author analyzed transcripts and their respective videos to determine if the use of Minecraft as a teaching tool effected student achievement, student self-efficacy, and the types of social engagement students demonstrated during the class. Open coding (see Chapter 3, page 56) determined themes throughout the text and a modified version of ethnographic observation while watching videos of the students in their class. Three major themes were found within the text of the transcripts and blogs: effectiveness, self-efficacy, and community of practice (Figure 18).

Indicators of effectiveness were drawn from several models measuring effectiveness in project-based and game-based classrooms. To measure effectiveness, works of Sandford (2006), McLean (2012), and Kang & Tan (2008) were examined to determine what defined environments that fostered positive outcomes and marked effective teaching when using game-based learning. Indicators of play were derived from Piaget’s cognitive theory of play. According to Piaget (1973) play allows children to practice things and reflect on what they have learned. During examination of the effectiveness theme, the indicator of play occurred regularly due to the learning environment being a game-based setting.
Level One Open Coding Themes

**Effectiveness**
- Student exhibition of exploration
- Student exhibition of completed structures
- Student exhibition of trial and error
- Student and teacher play
- Students build with intrinsic motivation to complete
- Student displays evidence of knowledge
- Student displays evidence of inquiry
- Learner-paced acquisition of knowledge
- Students transfer knowledge to outside instances
- Students actively engaged
- Students on task
- Teacher immediate feedback
- Students actively process educational content
- Students show intrinsic motivation
- Creativity fostered and exhibited

**Self-Efficacy**
- Student executes inquiry to other structures
- Student asks for others to visit their structure in effort to show success
- Student suggests to others additional competition for best structure
- Students exhibit control of one's environment
- Student exhibits a show of success from their build
- Student exhibition of Flow (student confidently understands subject matter)

**Community of Practice**
- Students and teachers interact to build a community within a 3D space
- Students acknowledge others achievements
- Students are quite logacious among one another and teacher
- Students freely share ideas and opinions with each other and teacher
- Students work together to achieve a common goal
- Students address shared problems

*Figure 18. Level one-open coding themes.*
In Bandura’s book, *Self-Efficacy: The Exercise of Control*, he focuses on various aspects of self-efficacy. These aspects provided a conceptual background and surveyed empirical evidence for the significance of self-efficacy. Further indicators of self-efficacy emerged from Csikszentmihalyi’s flow theory (1997). Self-efficacy according to flow theory is measured by the ratio of activity to high level of enjoyment (Csikszentmihalyi, 1997). Csikszentmihalyi (1997) asserts that the high ratio is indicative of a high level of self-efficacy.

Community of practice is summarized by Wenger (2008) as a group of people who share a common goal or concern for something the work on interactively as a cooperative group. Indicators for this theme emerged from this idea. First evolving from Lave and Wenger (1991) situated learning idea, this type of learning was expanded by Wenger as a means to capture tacit-knowledge in an educational or business setting that may not be easily identifiable by other means of classification (Wenger, 2008). During analysis this theme appeared most frequently given the nature of the class; game-based, team/group project assignments and challenges.

During the examination of the video, transcript text, and blog text, students consistently showed excitement throughout the class. In the student blog entries, the word “fun” was cited over 250 times during the course of the summer. Phrases such as “I love this class” appeared at least 10-15 times each session. With the exception of 5 students that had physical or mental disabilities and had health assistants with them, students frequently chose to work together to create structures within their theme but were also allowed to work independently if they preferred. Students who were shy or uncomfortable working in groups, worked independently but out of the 11 students that experienced this toward the end of the week, they showed
stronger tendencies to work collaboratively. Students and instructors worked in concert at the beginning of the class to set expectations and consequences for the classroom to work as a community of learners.

Within the transcript the words “trolling” and “griefing” appeared 43 times collectively among discourse of students and instructors. At the beginning of each session, instructors and students spoke specifically about staying on task, “trolling”, and “griefing”. Trolling (see Appendix C), cited 26 times in the transcript, is frowned upon by players because it incites a high level of frustration (Talley, 2014). It is possible, while trolling, to collect resources and inspect other elements within the 3-DVW (Instructor, 2014). In this setting, students were not allowed to troll; however, students were not restricted to certain geographic boundaries within the 3-DVW. Although trolling was not allowed according to student and instructor agreed rules it did occur. Incidents of trolling often appeared after day one of the session as students became more engaged in the class. At least one student per session was reprimanded for trolling.

Griefing (see Appendix C), cited 17 times in the transcript, was voted by students and teachers that this would not be allowed; however, at least one to two times per session, a student would disguise themselves and grief another team’s structure by knocking it down or throwing virtual TNT at the structure. This caused a high level of stress among students who built the building and other students who were excited about the creations erected around them. As a consequence, the student would be “frozen” or virtually removed from the game in a disciplinary “time-out”. This occurrence was not restricted to one time of day. Both morning and afternoon sessions were “frozen” at least twice during the week.
The primary focus of the lessons for each group of students was architecture. Each day, a different type of architecture was introduced and the students would create a world within that building theme. Each daily session was 4 hours in length with 3 hours of instructional time. Remaining time was allotted for snack/bathroom breaks and game time. Total instructional time per week was 15 hours. This time included class discussion, project work time, and assessment or project exhibition. At the conclusion of the week students explored the worlds they created and exhibited their creations followed by discussions.

Emergent Themes

The following details results linked to the three themes as illustrated by direct discourse from video transcripts and blogs, screenshots of students’ creations in the game, Minecraft, as well as photos of deliverables. When performing the discourse analysis on the collected data regarding verbal activity and social interaction among the participants, it’s important to note that not all of the discourse took place on the same day or same week. As a result, some data regarding, for example, instances of loquacious activity, were cited in the text as evidence of the themes but didn’t necessarily occur sequentially on the same day. Discourse cited among the themes were pulled from different sessions as discovered by the author during the analysis process.

Theme 1: Effectiveness

This theme is discussed in three parts based upon the data within the theme of effectiveness. Each part is based on: 1) whether the instructor or other students encouraging student engagement gave immediate feedback, 2) evidence of the transfer of learned knowledge to other instances, and 3) feedback participants’ willingness to inquire into the
subject matter (by asking other students or instructors). The findings report among these
themes but do not separate them as many of the lines of discourse and description overlap one
another. To report them in a segmented manner may devalue the findings of the data.

Flow theory, proposed by Mihalyi Csikszentmihalyi (1997), suggested that people are
intrinsically motivated to participate in an activity only for the sole purpose of doing rather than
strictly participating in an activity as a means to an end. During the Minecraft class students
exhibited high level of eagerness to participate. When the instructor indicated it was time to
recess from class for events such as snack breaks, restroom breaks, or that class time for the
day had ended, students were visibly upset and asked to continue playing the game. Some
asked to skip breaks for the sake of continuing and gaining more game playing time. Often,
instructors had to “freeze” the game to seize the students’ attention away from the game and
redirect them toward the break that was to take place.

T1: Let’s go to the snack break.
Students: snack break?
T1: Yes
Students: ahhh...nooooo. I’m not hungry. Can we stay in here if we’re not hungry?
T1: We just need to go for a ten-minute snack break.

Although this behavior may indicate some sort of compulsion, the students appeared to
show willingness to break after the discussion was held by the teacher that it was a short break
and they would have time to complete their structures. The students’ hesitation to break from
the game stemmed from enjoyment of the activity as well as concern of time restrictions to
finish their structures.

Students: What if we don’t finish?
T1: You’ll have time. Don’t worry.

Students: Are we going to work on this again tomorrow?

T2: We have a new project for tomorrow but if you’re not done you can work on this first before you start the new one.

Students: OK

The students’ intrinsic motivation was to continue playing to complete their structures and build the world in which they were tasked. During their build time, students invited other students, including the instructor, to see what they had built. This evidenced that they were actively processing the content and required immediate feedback, both of which were imperative to measure effectiveness.

Evidence of gained knowledge was not only clear through pre-/post-tests with 25% improvement from the base score, but also within the transcript of blogs and videos. Students brought prior knowledge of the theme to apply to their buildings and world creation. During builds they made suggestions to build according to ideas and information that was not covered in class but learned prior to their involvement in the course (e.g. Greek architecture lesson). Students spoke to one another in a way that to outsiders may be construed as chaotic or a discombobulated manner.

Unlike a traditional classroom, students were not restricted to indicators to request permission to speak such as raising their hands. Instead, a natural flow of conversation took place among students and teachers; at times, they spoke over one another in moments of excitement. This method of communication afforded students a natural setting in which they could bring prior knowledge and forge new knowledge.

Students: This is Greek, right? Yeah, temples are Greek, they always had temples.
Students: Let’s make Mt. Olympus. That’s where the Gods will live. I’ll start making thrones for the top of the mountain…. I’ll start a statue of Zeus. Did they worship statues in the temples?

Within the above text, students evidenced outside knowledge of Greek Gods, Mt. Olympus as their home, and were actively engaged and on task. They transferred this knowledge during their discussion regarding the planning phase of their world creation. In addition, self-efficacy was evidenced with the inquiry of one student regarding statues and religion in the Greek/Roman era.

Further, students’ immediate feedback via verbal discourse inspired students to remain actively engaged in learning. Student-to-student feedback and student-to-teacher feedback was substantiated throughout the class as evidenced in the video and transcript data.

Students: Ok *name* how’s the statue going?...Guys, I’m going to go help him...is that the hand...lightning...disappeared... oh, dude, that looks awesome, look at that....

<Blue Shirt goes to classmate’s computer.>

Students: Isn’t that awesome?...What’s awesome?...What’s awesome?...This is...the middle...people...no...look I’ll show you from a distance....

<Blue Shirt goes to his seat, with Tie Dye following him back to his computer.>

Students: Looks really cool, it looks better.

T2: I like those pillars guys

T1: What is that?

Students: He’s building me a statue of me...

T2: Guys, I love the statue of Zeus; that’s cool.

Immediate feedback effectively engages students in the learning process and correcting initially incorrect responses promotes retention of accurate material (Epstein et al., 2002).
Students and teachers in the Minecraft class not only immediately verbally corrected inaccuracies but also complimented good work to promote positive reinforcement.

Instructors and students worked with one another in the problem-solving efforts of creating a world within a predetermined theme. They also worked in concert at the end of the week to play a virtual game of “Capture the Flag”. Each instructor assigned themselves to a team of students. Teachers interacted with students through play; at times, they appeared to be equals who worked together to achieve a common goal. This contributed to the emergence of a lively and spirited learning space. Singer, Golinkoff, and Hirsh-Pasek (2006) posited that play encourages and enhances a child’s cognitive and emotional growth.

T2: Today we’re playing a little bit of PV and P (PVP).

Students: Yeah!

T1: There’s going to be two teams at the start, ok, guys? I’ll be on one team and T2 will be on the other.

Student: But do we get a little bit of time to get our stuff ready?

T2: Yes, the first half is going to be set to finish our builds.

Instructors who worked on their computer within the 3-DVW with their students encouraged the students to remain engaged and feel connected to their learning. Connected learning flourished in a socially important and information-rich environment of continuous interest, creativity, expression, and realization.

T1: I want you to walk in the direction of the right color for you so we can teleport you to the right side, ok?

Students: Ok. No, he needs to be here too....that makes seven.... Killerbrine and Slenderman are on their team, Gabby, they’ll protect you... Hey Gabriel...who’s Fishdiver?...oh, my goodness, look at the castle on the other side of our team.
T1: Give yourself a minute to set up your defenses and give yourself armor and all that stuff...if you want to, build defensive walls since it’s capture the flag.

Student: It is?

Student: What does green and orange mean?

<Students choose their sides>

T1: Yeah. Guys, the orange team has a jack-o’-lantern that the green team is trying to capture and the green team has a block of emerald that the orange team is trying to capture.

When instructors “played” the game with their students while remaining within their instructor role, they incited learning among students. Effectiveness is defined as the degree to which something produces a desired result (Merriam-Webster, 2015). Students that are actively engaged in learning while imparting their knowledge to build new knowledge are effectively learning. The Minecraft class at ATI kept students engaged while remaining creative. It was a ludic atmosphere that inspired students to take ownership in their learning.

Theme 2: Self-Efficacy

This theme yielded five areas that were narrowed to three areas in which self-efficacy was apparent within the video, video transcripts, blogs, and physical deliverables. Physical deliverables were completed worlds in which the author could go to examine structures completed by the student as well as printed models of the buildings. The three narrowed areas of this theme were: 1) exploration outside of personal space, 2) suggestions to others on areas of improvement, and 3) student control of their learning environment.

When students explored outside of their personal space, they exhibited an aura of confidence that could suggest that other avatars participating in the game or game creatures and obstacles did not inhibit the students or events that they may have come across. It is
suggested that students may better understand a theory or concept through exploration. Minecraft offers the opportunity for students to explore throughout the virtual world. In the private server set up by the ATI instructors, students were limited to exploration within the world that they were connected to within the classroom. Students connected to a specific IP address when the logged into the game to insure that they were all in the secure world and the instructors had access to them at all times.

Although the students were within the confines of a “private world” shielded from the outside public, they explored other structures frequently and often suggested improvements to other students or complimented them on their build. Most students explored virtually within the private world by maneuvering their avatar through the world by walking or flying, while some physically removed themselves from their chair and walked over to another student’s computer to see what they were creating. The instructors did not discourage walking to other student’s computers as long as the student did not disturb the workflow of those students and returned to their own task in a timely manner. This type of control over the student’s own learning environment not only encouraged engagement, but also suggests that students with Attention-Deficit/Hyperactivity Disorder (ADHD) may thrive in such an environment.

<Tie Dye gets up to look at Blue Shirt’s computer then sits down.>

Students: How many have we done?...we’ve done...oh have you...three more blocks we’ve gone 5...

<Tie Dye gets up, walks around, then sits down.>

Students: I’m going with golden...and I’m making the floor... we’re making the mountain eight layers high...can we?...no it’s not real, it’s myth...

<Dark Grey shirts comes to look at Blue shirt’s computer, then goes back to his seat.>
The preceding text excerpt from the video transcripts illustrates that the students moved about the room but stayed on task. They were curious to see what other students had created and were free to inquire. They did not need to be redirected to return to their seat since after they had explored and inquired they returned on their own accord to continue working. These interactions could be categorized within the self-efficacy theme but also could show a level of game-based learning environment as effective. Students made suggestions of improvement and took control of their learning environment, and gave/received immediate feedback from their peers.

Students worked in teams of two to three students to complete their structures. Figure 19 illustrates a medieval castle constructed by students enrolled in the ATI Minecraft class (2014).

*Figure 19. Screenshot image of student-built medieval castle.*
In the blog from June 24, 2014, the instructor reported what the students worked on that day:

Today we worked in teams on our server to build medieval castles. We focused on making moats, towers, and dungeons. Today we covered Medieval, Baroque, and Gothic architecture before diving straight into Minecraft and constructing buildings in the styles covered. The Notre-Dame de Paris was included in the map beforehand as inspiration and reference, but all other buildings were built 100% by the students themselves working in teams. One team opted to build a highly-detailed and decorated castle while the other built a village complete with garden, windmill, church, Coliseum (some liberties were taken with historical accuracy) and town wall. (ATI Blog, 2014).

Once more, the data evokes overlap among the themes. Students transferred knowledge in to the projects and reported their successes and frustrations on the daily blog entry. Some students extended their community from the classroom to outside of the learning day by replying to student posts. Students were receptive to this knowledge as they replied in their own blog post regarding the lesson for that day.

Student: I learned how to make medieval house and what it looks like (ATI Blog, 2014)

The phrase “house” and “what it looks like” is indicative that the student understood that a castle is where someone lived and she was receptive to the parts that made up the structure.

Student: I helped build the moat for our castle so that the bad guys wouldn’t attack us. It was fun. I love this class. (ATI Blog, 2014).

This student’s entry could suggest that they were not only exhibiting efficacy by the transfer of knowledge into the build of their structure but they knew that they built something
to protect their team’s structure. This shows a positive learning outcome from the student’s work as well as their discourse in the blog entry.

This entry advocates the student’s control of their learning environment; and, by reporting on the blog that they had fun building, they exhibited a show of success.

Upon completion, the students exported certain structurally sound models in an effort to print them on a 3-D printer. The photo of the castle in Figure 20 is the completed 3-D print of the castle from the screen shot in Figure 19 (above). Students exported their structure into an .STL file format and uploaded it to proprietary software linked to the 3-D printer supplied by ATI.

![Photo of a 3-D print of a student-built medieval castle.](image)

**Figure 20.** Photo of a 3-D print of a student-built medieval castle.

Within the theme of self-efficacy, the author looked for evidence of student control of their learning environment. In many instances throughout the class videos and transcripts, students referenced competition among the players for the best structure. This idea of
competition promoted a student’s confidence in their ability to build a sound structure that would also be the most aesthetically pleasing to the judge or their peers. From the transcript, the students said:

No...that’s the best bridge ever...now, look...Let’s see who can build a better bridge...oh, geez...somebody put lava everywhere...oh, my gosh *name*...what...that’s me...oh, I don’t...sorry...oh, my gosh...you came at me—I thought you were my opponent...maybe you should do a judging competition...yeah...and I most certainly would win...the most creative, the tallest...

Students challenged themselves and others to build “the best” creations and at one point even added certain stipulations by stating the structure should be “the most creative, the tallest”.

Instructors allowed this type of competitive environment, which inspired students to remain engaged in their task at hand. Students who did not want to participate in the competition portions of the class were not forced but instead allowed to build on their own within the private world furnished by the instructor’s privately run server. Most students did not choose this option but instead either built in teams or independently to compete against others in the class.

Data analyzed within the confines of this case study exhibited student inquiry, exploration, confidence with suggested competition, as well as student show of success. Through observation of the video and scrutiny of video transcript and blog text, it was found that most of the students enrolled in the Minecraft classes exhibited belief in their own capacity to execute the behaviors necessary to complete the tasks set before them. Instructors facilitated learning and had to implement very little redirection of students to keep them engaged in the lessons.
Community of Practice

Individuals working toward common or shared goals in a collaborative manner are known as Community of Practice (Wenger, 2008; see also Appendix C and chapter 2). Community of practice was most evident throughout the data. Students often worked together to achieve common goals and addressed shared problems. At the beginning of each week (one session), instructors worked with the students to set class expectations and classroom rules for everyone to follow. The students took ownership of the opportunity to suggest items that corresponded with the type of class in which they were enrolled, such as no griefing or trolling; purposely destroying other players’ structures or harassing other participants and stealing their resources. They built a community of learners who were expected to follow classroom rules established by the group as a whole.

In the following text, students were working in teams to create a space city. The students completed a structure within the predefined theme given by the instructor. Their intent was to create a city in space that would pose post-modernistic buildings. They chose to use tall buildings and were excited that their building mimicked a rocket ship. As they completed their structure they asked the teacher and other students within the community to look at their accomplishment. This evidences community of practice among learners.

Students continue to build and add lights.

Student: Did you see ours?...preview ours, preview ours!

Student: Why don’t we make it like rounded?

Student: We’re still working on the top, though.

Student: Yeah, look at the tall buildings right there...yeah, tall buildings tall buildings...looks like a fat rocket ship.
Throughout the data text the terms “we”, “we’re”, “let’s”, our, and “us” appeared multiple times when the students and instructors spoke, indicating that the group of learners were included in the context of the discourse. The following text are excerpts from video transcripts exhibiting students working within a community of practice.

Students: Let’s sacrifice a horsey in golden armor to the altar.

Students: Let’s make Mt. Olympus...good idea you and me *name*, come on...

Students: Let’s make Mt. Olympus...a mountain we’re making a mountain.

Students:...You guys just gave me an idea; let’s make an awesome walkway.

Students: We don’t know what we should- we have a little bit of trouble with what we're doing on the top...

T1: Wait *name*, *name* and *name* we’re ending it right there.

Students: We’re trying to build something but we are having trouble...someone help us!

Students: Send us help, someone help us, they’re shooting us!

Students: Don’t you dare grief us...Why?...Because we didn’t do it. Who griefed our tower?

T2: Let’s try to find the river.

T1: Today we’re going to play pvp.

Students were working as a cohesive unit to accomplish common goals by sharing problems to solve along the way to achievement of these goals. The instructor did not force the students to work as a team to build but encouraged them to work together to create a system that would engage the students in problem solving to generate a more complex structure that may not have been possible within the confines of the time limits set by the structure of the class. Students selected their own teams and in the event that someone wanted to work with a team but didn’t know anyone, the instructor would ask the class as whole if any team had a
place for that student. At no time was a student forced to work alone in the event that a
natural team selection didn’t occur. Multiple groups of students were eager to invite others to
their team.

Students and teachers interacted throughout the class in many ways. Students
physically moved about the room and spoke to one another as well as virtually moved about
the private 3-D virtual world. Some chose to use the chat function available in Minecraft rather
than physically speak out loud to other students.

T1: Did everyone get the message?

Students: No...Oh, yeah...to the chat. I see it.

This may have occurred because of the constant chatter among students. Those that
used the chat room may have felt it was a more viable way to communicate rather than
attempt to speak over those that were already speaking. The following excerpt is taken from a
section of the video transcript where the instructor held a tablet connected to the private
server to show a private chat between two students, Waiter and Samurai, as they built a
restaurant in their space city. Spelling and font case were not altered to illustrate the natural
discourse interaction between these two students. It also shows suggestions given by the
Minecraft software to successfully build and maneuver within the program. T2 held up the
tablet to the camera to show chat log:

Samurai: I wana eat now!

Samurai: im health inspector im dizzy to lollololooolololololo

Build mode has been enabled.

You can toggle between build modes by pressing left ctrl,
You can change the distance with mouse scroll or by pressing +/-.

Can’t enable Spectate mode while Build mode is enabled.

Build mode has been disabled.

You are now in build mode.

Samurai: im health inspector im hungry to lollollolloololololo

Samurai: I wana eat now!

Waiter: where do I put money

Samurai: BOOM I DIED

Waiter: if john is head chef, what is he doing? hes just sitting in his kitchen and doing nothing

Samurai: i wana eat now!

Samurai: THAT’S IT IM LEAVING BAD REVIEW

Samurai: jk fine!

Samurai: im coming now

Students were not concerned with spelling but instead conveying a message. Some used all capital letters to evoke a high level of emotion in their message. Others used abbreviated chat implying the other participant would understand this type of texting language without explanation. This real-time, text-based form of communication is commonly found in texting and chat rooms (Smeaton, 2014).

Since this was a private server, the instructor could asynchronously monitor all chats started by students. This afforded the student control of their environment while still allowing the instructor to actively monitor and manage their class.

Although the idea of working together to achieve a common goal is age-old, the term “community of practice” is somewhat new. The students in the Minecraft classes worked
together to build a world that was within the theme of a specific type of architecture assigned by the instructor. Castles, towers, coliseums, bridges, dungeons, and moats were erected as evidence of students creating and learning from one another. The students were, in many instances, quick to self-govern others who were off task or not working for the betterment of the group. Working together they completed simple and complex structures within their community.

Conclusion

This chapter looked at each part of the analysis starting with the data gained from instruments and surveys followed by the analysis of transcripts and videos. Analysis to each of the three primary themes was provided. The following chapter will discuss these findings, elicit recommendations for future studies and implementation, and draw conclusions from the evidence.
CHAPTER 5
DISCUSSION, RECOMMENDATIONS, AND CONCLUSIONS

Edutainment games are video games that are dual purposed for the intention of children learning academic content while having fun learning (see Appendix C). Papert (1998) argued against the use of what is now known as edutainment games merely for the purpose of entertainment but stressed the value that these video games can bring to teaching and learning. Students that are often recalcitrant in the typical teacher-delivered, paper and pencil lesson have been correlated with more actively engagement in lessons that are driven by video games. Games that require working in a 3-D virtual space not only lessened recalcitrant behaviors, but students also worked cooperatively with others in the group to accomplish a common goal. Past researchers, as stated in Chapter 2, have posited this as well and it is supported in the data from this study.

Creswell professed (2013, p. 183), “Grounded theory design is a systematic, qualitative procedure used to generate a theory that explains, at a broad conceptual level, a process, an action, or an interaction about a substantive topic.” Using a grounded theory perspective, the author initially began analysis by searching for major themes that answered the question: Can the use of 3-D spaces evoke other knowledge by using tools such as Minecraft? Three themes were analyzed from the data.

The driving question behind this case study was “Can the use of 3D spaces evoke other knowledge by using tools such as Minecraft?” From this, it was broken into three fundamental questions to frame this research:

1. Is Minecraft an effective tool to acquire other knowledge when teaching predefined objectives?
2. How is a students’ self-efficacy affected when utilizing game-based learning such as Minecraft?

3. What kind of social engagements provide opportunity for acquiring knowledge by utilizing 3-DVW such as Minecraft?

Within the three major themes derived from open coding—effectiveness, self-efficacy, and community of practice—axial coding was then utilized to determine six sub-themes. The category development narrowed the data results and focused on repetitive and common occurrences and discourse evidenced with the text. Although the themes are reported as individualized there are many areas where areas overlapped. Figure 21 illustrates the sub-themes within each category that were revealed during the open coding process.

Figure 21. Can the use of 3D spaces evoke other knowledge by using tools such as Minecraft?

Edutainment games are video games that are dual purposed for the intention of children learning academic content while having fun learning (see Appendix C). Papert (1998) argued against the use of what is now known as edutainment games merely for the purpose of entertainment but stressed the value that these video games can bring to teaching and learning. Students that are often recalcitrant in the typical teacher-delivered, paper and pencil
lesson have been correlated with more actively engagement in lessons that are driven by video games. Games that require working in a 3-D virtual space not only lessened recalcitrant behaviors, but students also worked cooperatively with others in the group to accomplish a common goal. Past researchers, as stated in Chapter 2, have posited this as well and it is supported in the data from this study.

Creswell professed (2013, p. 183), “Grounded theory design is a systematic, qualitative procedure used to generate a theory that explains, at a broad conceptual level, a process, an action, or an interaction about a substantive topic.” Using a grounded theory perspective, the author initially began analysis by searching for major themes that answered the question: Can the use of 3-D spaces evoke other knowledge by using tools such as Minecraft? Three themes were analyzed from the data.

The driving question behind this case study was “Can the use of 3D spaces evoke other knowledge by using tools such as Minecraft?” From this, it was broken into three fundamental questions to frame this research:

1. Is Minecraft an effective tool to acquire other knowledge when teaching predefined objectives?
2. How is a student’s self-efficacy affected when utilizing game-based learning such as Minecraft?
3. What kind of social engagements provide opportunity for acquiring knowledge by utilizing 3-DVW such as Minecraft?

Within the three major themes derived from open coding—effectiveness, self-efficacy, and community of practice—axial coding was then utilized to determine six sub-themes. The category development narrowed the data results and focused on repetitive and common occurrences and discourse evidenced with the text. Although the themes are reported as
individualized there are many areas where areas overlapped. Figure 19 illustrates the sub-themes within each category that were revealed during the open coding process.

Theme 1: Effectiveness

Within this text it was evident that student effectiveness was strong as students were actively engaged with their assignment. The data showed that students were able to evoke other knowledge when Minecraft was used as a teaching tool. Students were inspired to be creative through intrinsic motivation and the element of competition. Many students were visibly upset when asked to take a break from the class for bathroom breaks and snacks or to complete their blog assignment for the day. The students did not want to leave their 3-D virtual world environment and resign from their task at hand–creation.

High levels of creativity were shown as the students built detailed castles, unusually shaped tall buildings, and accessories that they deemed necessary for the success of their structure to be viable within their 3-DVW. Most often students took into account prior knowledge in creating their worlds. This was evidenced in the building of Mt. Olympus and creating a place to sit on top of the mountain for the Greek gods. They saw it necessary to build a structure that would overlook the other structures for the gods to look down upon their people.

Immediate feedback was necessary for the students during their classes. However, it was not always feedback from instructors, as in many traditional classes. Students often gave feedback to one another in order to achieve a common goal. Students took these suggestions seriously in their quest to solve problems on their path to success. This is a natural way for humans to learn and is a realistic way of functioning in the 21st century workforce.
Pre- and post-test assessments showed gains of knowledge. Students scored 25% higher than their initial exam taken at the beginning of the week. This growth would be evidenced in the final world that was built by the students in a summative assessment. When examined by the author it was found that buildings were very detailed. They included lighting, furniture, protective structures (e.g., moats and drawbridges), water resources (aqueducts), and landscaping. When prompted, students freely shared their reasoning behind their creations. This supports Vygotsky’s theory of cognitive development (Bruce, 2011). It shows that the students are using language to develop their understanding of the subject matter and new knowledge is then formed.

From a pragmatic point of view, the interaction of the students with the 3-DVW affords them the opportunity to form thoughts based on their experience through the game of Minecraft. The usefulness of Minecraft as a tool would support Dewey’s theory of instrumentalism through the successes evidenced by the use of Minecraft as a tool. Students worked cooperatively to construct new knowledge and deliver products that could be summatively assessed to determine if new knowledge had been gained.

Theme 2: Self-Efficacy

It could be suggested that the students’ self-efficacy was high because they were eager for others to examine their building, which illustrated their confidence in the success they had achieved. Students were also eager to explore and inquire into structures built by other students in their community of learners. Many physically moved about the room in addition to exploring the world virtually. This physical movement may be due to students’ need for
immediate information rather than taking the time to move through the 3-DVW to search for a specific structure then moving back to continue their own.

As was evidenced in the first theme of effectiveness, feedback was a vital part of the learning process. As indicated by McClenaghan and Ward (1987), feedback has two imperative capacities: inspire students, and equip them with information that they can use to remedy or ameliorate their learning. Students that explored outside of their own personal space showed that they were searching for ideas and affirmation regarding their build. The students that physically moved to another student’s computer to view the work always returned to their seat and began to work from the point where they left. Often, using ideas that were given to them by other members of their learning community, they would make improvements to their structure.

The students had confidence in their build, which showcased an environment of control among the students. They were allowed to take ownership of their learning by creating a class set of expectations and behaviors at the beginning of the session, freedom to move about the room, and ability to approach the instructor at any given time for feedback or play interaction. This self-efficacy was further evidenced by the student-suggested competitions among learners to build the “best” building. Students also set the specific criteria for the competitions, revealing further control of their learning environment.

Badura’s idea of self-efficacy is the confidence one has when performing a task. Students of all skill levels showed confidence when working with Minecraft as a tool in the classroom. Students that had little or no experience with Minecraft turned to others for help to navigate the software until they had built a strong sense of self-efficacy and could work
independently. The community of learners was strong and worked as a cohesive unit, as discussed in the next section.

Theme 3: Community of Practice

The utilization of Minecraft as a tool to acquire knowledge fosters a strong environment to promote a community of practice. According to Lave and Wenger’s theory of community of practice (1991), students work together to solve common problems and achieve common goals. In this case study, students were given a specific theme (e.g. Greek architecture) to build a viable world in which inhabitants could thrive. Students naturally self-selected other students in the class with which to work. They also assigned roles to everyone to complete varying tasks. When certain students strayed off task or broke any of the pre-established community rules, the students would self-govern by correcting the student who broke the flow of learning and redirect them to their assigned role.

Play was strongly evidenced in the data. Play, according to Piaget is vital to a student’s learning (Small & Vorgon, 2008). In the ATI Minecraft class the students stayed focused but also interacted and joked with one another during the class. The instructors were also involved in this behavior, which created a fun learning environment where the students were hesitant to leave at the conclusion of each session. Student-created competitions throughout the week and the PVP (player versus player) game of Capture the Flag at the conclusion of the week created a driving motivation for students to succeed.

The community of practice theme was the strongest throughout the data. Although individually, the students showed progress and acquired knowledge, the students mostly worked together in teams of two or three to accomplish tasks designed by them in a problem-
based and project-based learning style. This dynamic approach to teaching better afforded the learners to dig deeper and actively explore problems than if they had been given a conventional paper and pencil assignment most commonly seen in a traditional classroom.

Student interaction came in many forms. Most students chose to speak aloud to other students or move about the room and return to their seat, but some chose to utilize the chat function Minecraft offers its users or move their avatar throughout the 3-DVW to explore. In a traditional classroom, interaction may be more limited, therefore inhibiting the students’ ability to work cooperatively to form new knowledge.

Overall, there was a strong sense of excitement in the room while students played Minecraft and built their worlds in the virtual space. Students appeared happy to be in class and at times did not want to leave. This is a strong indicator of a love of the lesson and taking ownership in their learning.

Recommendations as a Result of This Study

Recognizing that schools may face many challenges in the implementation of game-based learning, this study points to three recommendations that may assist in the integration of game-based learning into the regular curriculum of educators: preparation, creativity, community of learners, and future study recommendations.

Recommendation 1: Preparation

Preparation is the first recommendation to implement game-based learning. Educators must learn the game before attempting to use it as a teaching tool in their classroom. The ATI instructors were fully prepared by not only setting up a private server prior to the beginning of class but also playing Minecraft at home to gain a full understanding of the game. Just as it is
recommended (and at times mandated) that a teacher watch a video prior to showing it in their classroom, the same idea must be implemented in game-based learning. The more a teacher is prepared, the more successful their lesson may be.

Recommendation 2: Be Creative and Foster Creativity

If an educator wishes to implement game-based learning environment within their classroom they must be creative. Students will grow bored very quickly if their task is mundane and banal. Invite students to create complex problems and goals to complete. There are many forums and websites from which a teacher can draw ideas. Core curriculum can be integrated into a lesson in Minecraft but preparation and creativity must be used to achieve success.

Recommendation 3: Create a Community of Learners

Foster a creative community of learners. Trial and error is often the best learning tool so if an educator is creative and can break down the hierarchy walls between teacher and student and create a fun community of learners then students may be more apt to take ownership of learning. In this study, students controlled their environment although ultimately the teacher had the power to freeze the game if redirection was needed. This was not needed because the students self-governed. Students worked together to create detailed worlds and brought with them prior knowledge to share in the creation of their world.

Suggestions for Future Research

In future studies of this nature, the author would recommend that a control group be implemented to compare gains. In this study everyone took the pre-test, created thematic worlds, and blogged. This data showed the lessons were engaging and the final projects evidenced learning from the detailed and complex structures created by the students.
However, there was no basis from which to compare a traditional lesson teaching the same theme versus the lesson that utilized Minecraft in a game-based learning environment.

During this study, parent perceptions of the use of 3-D virtual worlds in the classroom was not pursued but is recommended for future study. This study served as a foundational basis on which other studies regarding gaming and Minecraft or other 3-D spaces are used in an educational setting.

Conclusion

This research study illustrated a gained increase in understanding regarding the attainment of other knowledge through the use of 3-D spaces in a game-based learning environment. Although there were vast amounts of literature pointing to the successes and positive reasoning behind the use of game-based learning in the classroom, there were a limited number of case studies in which the game, Minecraft, was examined as a tool for teaching and learning. Although the limited number of case studies was available, there are several websites offering lesson plans that use Minecraft as tool in the pedagogy. This indicates that many teachers may be using Minecraft, however, they may not have supporting research as a foundation for their decision to use the game.

Problem-based Learning with Minecraft

A collaborative familiarity of game strategies among numerous students is achievable by playing Minecraft. The game has highly regarded, multiplayer system integration so that one-to-one collaboration of students in the virtual world is nearly as instant as the real world. For shared knowledge based lessons to be successful, the consideration of various factors is necessary, such as grouping clusters of like-minded individuals and judging every group
member’s capacity and determination to create the best team. Because Minecraft has gained in popularity, it may be more probable that the recognition and usability of game-based learning is now acknowledged. By understanding game dynamics, the user can become acquainted with many of the world’s most current technologies.
APPENDIX A

PRETEST TO MINECRAFT CLASS
Minecraft Prequiz
Let's see what you do or do not know. No pressure. No stress. Just have fun and see what you know and take a peek at what you'll learn during this fun week of Minecraft!

1. Match the picture with the term (2 points)

   ______

   a. Vault
   b. Dome

   ______

2. The ______ is an ancient Roman temple in Rome, which uses a huge dome. (1 point)
   ○ Pantheon
   ○ Colosseum
   ○ Trevi Fountain
   ○ none of the above
   ○ I don't know

3. A ______ arch is a huge monument built to celebrate great victories or achievements. (1 point)
   ○ Triumphal
   ○ Victorious
   ○ Celebration
   ○ none of the above
   ○ I don't know

4. Roman architecture is known for its advancements in the use of ______ and coliseums. (1 point)
   ○ concrete bricks
   ○ wooden planks
   ○ asphalt
5. In Medieval times large churches, built up to 30 stories tall, were called _______. (1 point)
   - cathedrals
   - shanties
   - colosseums
   - none of the above
   - I don't know

6. The long central section of the medieval churches was called the _______. (1 point)
   - nave
   - transept
   - hallway
   - none of the above
   - I don't know

7. The shorter sections of the medieval churches was called the _______. (1 point)
   - transept
   - nave
   - closet
   - none of the above
   - I don't know

8. The walls of the gothic cathedrals were supported by stone arches called _________. (1 point)
   - flying buttresses
   - trellises
   - tubes
   - none of the above
   - I don't know

9. Renaissance architects favored __________ of architecture. (1 point)
   - Chinese styles
   - Roman/Greek styles
   - Aztec styles
   - none of the above
   - I don't know
10. Which statement best describes the architecture style of this building? (1 point)

- The architect adapts elements of modernism and classicism in the design.
- It is purely modernist building.
- The building is neo-classical in style.
- none of the above
- I don't know

11. What is a major difference between modernist and postmodernist architecture? (1 point)

- Modernist architecture rejects ornament and postmodernist architecture embraces it.
- Modernist architecture uses irony and wit while postmodernist architecture rejects it.
- Modernist architecture is neo-eclectic and postmodernist architecture is rigid.
- none of the above
- I don't know

12. City of the Arts and Sciences is in _______. (1 point)

- Valencia, Spain
- Rome, Italy
- Frankfurt, Germany
- none of the above
- I don't know

13. This building is a tall ________ which brings with it connotations of very modern technology. (1 point)
14. Petronas Towers in Malaysia were designed by César Pelli. (1 point)

- skyscraper
- tower
- pyramid
- none of the above
- I don’t know

- Kuala Lumpur
- Bangkok
- Beijing
APPENDIX B

PRESIDENT AND INSTRUCTOR INTERVIEW QUESTIONS
Questions for instructor and president interview:

1. What is your name and position here at ATI?
2. What is Arts and Technology Institute?
3. When did Arts and Technology start?
4. What is your educational background?
5. What is the educational background of other instructors at ATI?
6. How many instructors are employed at ATI?
7. What is the student to teacher ratio?
8. What is the structure of the class? Is there a set schedule? Are there predefined teaching objectives?
9. How is the classroom arranged?
10. What is the reasoning behind the table/chair arrangement for students and teachers?
11. Who assigns roles to students and teachers?
12. What if any, credentials does ATI have?
APPENDIX C

DEFINITION OF TERMS
The following definition of terms found within this research is informed by the Edshelf Educational Technology Dictionary (Lee & Sha, 2012).

4. **Classroom Management** – A mental technique utilized by educators to minimize classroom disturbances and expand a learning environment. Despite the fact that various strategies can be utilized, they, for the most part, fall into the utilization of positive or negative fortification.

5. **Educational Technology (edtech)** – Any sort of technology that is utilized for instructive purposes by a teacher or instructive establishment. Most ordinarily utilized as a part of reference to software used in essential, optional, and advanced education; however, it can cover substantially more.

6. **Gamification** – The act of applying diversion mechanics into an action. Samples of diversion mechanics are objectives, emblems, rivalry, prompt criticism, and step up.

7. **Instructional Technology** – A subset of education technology, this practice concentrates all the more on the utilization of technology for instructional purposes; however, the terms are frequently utilized reciprocally.

8. **Project Based Learning (PBL)** – A showing technique focused around the thought of "learning by doing". Students chip away at an involved genuine movement that exhibits the ideas they are learning. PBL has a tendency to have high level of student engagement.

9. The remaining terms referred to within this research are supported among various resources.

10. **3-D Virtual World (3-DVW)** – A 3-d [three-dimensional] computerized environment in which clients are spoken to on screen as themselves or as made-up characters and collaborate progressively with different users (Golub, 2010).

11. **Archival Data** – Data not directly accessible to the researcher, maintained by an entity for long-term recordkeeping purposes that is collected prior to the study. May be in the form of written media such as audio or video recordings, spreadsheets, documents, or physical artifacts (Creswell & Clark, 2011). In this particular case study, archival data will be used that is made available by Arts and Technology Institute.

12. **Community of Practice (CoP)** – an engagement of individuals who are involved together in collective learning within the constructs of a shared endeavor. The process can evolve as a result of a group of people, such as, students’ and instructors’ concerted interests toward specific ideas or concepts, or it can be made particularly with the objective of obtaining learning identified within their field. It is through the procedure of sharing knowledge and experience through the mutual undertaking that the participants gain
from one another, and construct new expertise from which to frame and implement to future learning experiences (Lave & Wenger, 1991).

13. Edutainment – Edutainment is a termed coined by game developers to describe video games that are educational in nature. It is a hybrid of educational entertainment (Papert, 1999).

14. Game-based learning (GBL) – is a sort of diversion play that has pre-specified learning results. For the most part, game-based learning is intended to adjust topic with gameplay and the capacity of the player to hold said topic applicable to the real world (Belloti et al., 2009).

15. Griefing – To intentionally attack players or destroy/steal another player's property on a multiplayer server. Generally frowned upon or banned (minemem.com/glossary, 2015).

16. Minecraft – Discharged in 2009, the sandbox game was made by Swedish programmer Markus Persson. It now has more than 40 million clients and earned over $100 million last year through individual game deals and promotion materials (Schifter & Cipollone, 2013). In the fall of 2014, Minecraft was purchased from Microsoft for 2.5 billion dollars (Hill, 2014).

17. MinecraftEdu – Educational version of Minecraft designed by educators for use in the classroom. It offers the ability of utilizing a private LAN server within the classroom to constantly monitor player actions, delegate resources to players, and interact with players within the confines of one virtual space not available to users outside of said server (Schifter & Cipollone, 2013).

18. Sandbox Game – is a style of amusement in which negligible character impediments are set on the gamer, permitting the gamer to wander and change a virtual world freely. Rather than an iterated advancement style gaming, a sandbox game stresses wandering and permits a gamer to choose undertakings. It is reliant on one’s intrinsic motivation to reach goals in the manner they see best (Belloti et al., 2009).

19. Self-Efficacy (SE) – Self-efficacy is the degree or quality of one's faith in one capacity to finish undertakings and achieve objectives (Ormrod, 2006).

20. Situated Learning (SL) – Jen Lave and Etienne Wenger (1991) first proposed the ideas of situated learning. Situated Learning is a matter of making significance from the true exercises of day by day living. SL posits that learning happens through connections among individuals and bringing forth prior knowledge with true, casual, and regularly unintended, logical learning. Brown et al. (1989) further builds upon this definition by stating:
Cognitive apprenticeship supports learning in a domain by enabling students to acquire, develop, and use cognitive tools in authentic domain activity. Learning both outside and inside school, advances through collaborative social interaction and the social construction of knowledge. (Brown, Collins, & Duguid, 1989)

21. **Trolling** – Similar to griefing where players are attacked or property is stolen/destroyed except that afterwards any damage is repaired or stolen property return by the destructive player (minecraft.gamepedia.com, 2015)

22. **Understanding by Design (UbD)** – Understanding by Design teaching methodology is utilized for educational planning focused on "teaching for understanding" (McTighe & Wiggins, 2006).
APPENDIX D

COLLECTION OF FIGURES
Figure D.1. Empty virtual space used for building and resource mining in Minecraft

Figure D.2. Minecraft 3-DVW screen shot.

Figure D.3. Gothic architectural them structure built in ATI Minecraft class.
Figure D.4. Trichotomy of Learning Theory in Game Based.

Figure D.5. Benefits of Pedagogy Utilizing 3D Virtual Worlds within Curriculum.

Figure D.6. Implications of Pedagogy Utilizing 3D Virtual Worlds within Curriculum.
Figure D.7. Fink’s Versus Bloom’s Taxonomy Visual Comparisons.

Figure D.8. What is your age? What is your gender?

Figure D.9. What is your age? What is your gender?

Figure 10. Have you taken a Minecraft class before this week?
Figure D.11. How many hours do you spend playing Minecraft?

Figure D.12. Classroom seating configuration.

1. Match the picture with the term (2 points)
   
   [Image of two architectural structures]

   a. Vault  
   b. Dome

Figure D.13. First question from assessment for students enrolled in Minecraft courses.
Figure D.14. Hahn’s qualitative coding breakdown/description diagram.

Figure D.15. Gaming preferences: Minecraft & other games?

Figure D.16. Pre-test-architecture knowledge.

Figure D.17. Post-test-architecture knowledge.
Level One Open Coding Themes

- **Effectiveness**
  - Student exhibition of exploration
  - Student exhibition of completed structure
  - Student exhibition of trial and error
  - Student exhibition of progress
  - Student ability to identify and correct mistakes
  - Student growth in evidence of knowledge
  - Student display evidence of inquiry
  - Learner-based acquisition of knowledge
  - Students transfer knowledge to outside instances
  - Students actively engaged
  - Students display positive feedback
  - Students actively promote educational content
  - Students show intrinsic motivation
  - Creatively constructed and exhibited

- **Self-Efficacy**
  - Student exhibits impetus for other structures
  - Student acts as a facilitator, their structure is driven by desire for success
  - Student suggests additional competitive for best structure
  - Students exhibit control of environment
  - Student exhibits desire for success from their build
  - Student exhibits of new (student confidently understands subject matter)

- **Community of Practice**
  - Students and teachers interact to build a community within a 3D space
  - Students acknowledge others’ achievements
  - Students support each other’s vision and ideas
  - Students freely share ideas and opinions with each other and facilitator
  - Students work together to achieve a common goal
  - Students address shared problems

Figure D.18. Level one open coding themes.

Figure D.19. Screenshot image of student-built medieval castle.

Figure D.20. Photo of 3D-print of student-built medieval castle.
Can the use of 3D spaces evoke other knowledge by using tools such as Minecraft?

Figure D.21. Level two and three coding focused coding and axial coding.
APPENDIX E

BLENDED CLASSROOM OBSERVATION FORM
### Blended Classroom Observation Form

<table>
<thead>
<tr>
<th>AET</th>
<th>PET</th>
<th>OFT-M</th>
<th>OFT-V</th>
<th>OFT-P</th>
<th>SMGp:TPsnt</th>
<th>LgGp:TPsnt</th>
</tr>
</thead>
<tbody>
<tr>
<td>6, 6, 12</td>
<td>4</td>
<td>1, 3, 5,</td>
<td>20,</td>
<td>5</td>
<td>7, 6, 9, 12,</td>
<td>17, 18, 19, 8, 11</td>
</tr>
</tbody>
</table>

1. Fidgeting
2. Out of seat and off task
3. Out of seat but on task
4. Quietly working independently
5. Physical aggression towards others or equipment
6. Eager to share work
7. Shows intrigue or is inquisitive of peer work
8. Inquires to teacher
9. Speaks over another peer or instructor
10. Shows frustration due to peer behavior
11. Makes suggestions about assignment
12. Takes on a leadership role within group
13. Trolls or grieves other students work or resources
14. Eagerness to please group members
15. Eagerness to please teacher
16. Provides feedback to peers
17. Solicits feedback from peers
18. Student interacts by methods of play with peers
19. Student interacts by methods of play with teacher
20. Student speaks off topic/off assignment

*Note: Actual recording was done by hand utilizing transcripts for over 62 hours of video.*
APPENDIX F

CLASSROOM SELF-EFFICACY OBSERVATION FORM
Classroom Self-Efficacy Observation Form

<table>
<thead>
<tr>
<th></th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students and teachers interact to build a community within a 3D space</td>
<td>♦♦</td>
<td></td>
<td>♦♦</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students acknowledge others achievements</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Students are quite loquacious among one another and teacher</td>
<td>♦♦♦♦♦</td>
<td>♦♦♦♦</td>
<td>♦♦♦</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Students freely share ideas and opinions with each other and teacher</td>
<td>♦♦♦♦♦</td>
<td>♦♦♦♦</td>
<td>♦♦♦</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Students work together to achieve a common goal</td>
<td>♦♦♦♦♦</td>
<td>♦♦♦♦</td>
<td>♦♦♦</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Students address shared problems</td>
<td>♦♦♦♦♦</td>
<td>♦♦♦♦</td>
<td>♦♦♦</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

*Note: Actual recording was done by hand utilizing transcripts for over 62 hours of video.*
APPENDIX G

IRB APPROVAL LETTER
April 23, 2014

Dr. Scott Warren  
Student Investigator: Jami Roberts-Woychesin  
Department of Learning Technologies  
University of North Texas

RE: Human Subjects Application No. 14-157

Dear Dr. Warren:

In accordance with 45 CFR Part 46 Section 46.101, your study titled “Understanding 3D Spaces Through Game-Based Learning: A Qualitative Case Study of Knowledge Acquisition through Problem Based Learning in Minecraft” has been determined to qualify for an exemption from further review by the UNT Institutional Review Board (IRB).

No changes may be made to your study’s procedures or forms without prior written approval from the UNT IRB. Please contact Jordan Harmon, Research Compliance Analyst, ext. 3940, if you wish to make any such changes. Any changes to your procedures or forms after 3 years will require completion of a new IRB application.

We wish you success with your study.

Sincerely,

[Signature]

Patricia L. Kaminski, Ph.D.  
Associate Professor  
Chair, Institutional Review Board

PK.jh
APPENDIX H

DEMOGRAPHIC SURVEY
Minecraft Participants Survey

We want to know about you.

Please take this short quiz about you and your experience with Minecraft.

1. Have you taken a Minecraft camp with ATI before this week?
   - [ ]

2. What is your age?
   - 8
   - 9
   - 10
   - 11
   - 12
   - 13
   - 14 or older

3. What is your gender?
   - Female
   - Male

4. On a typical week, about how many hours do you spend playing Minecraft?
   - 0-1
   - 2-3
   - 4-5
   - 6-7
   - More than 7

5. Gaming preferences: Minecraft and other games
   - I only play Minecraft
   - I play other games. Minecraft is the one I spend more time playing
   - I play other games. Minecraft only from time to time
   - This is my first time playing Minecraft.
APPENDIX I

RESEARCHER AS INSTRUMENT
I am a certified teacher in two states; Oklahoma and Texas. In Oklahoma I am certified to teach Grades 1-8 and in Texas my certifications are Generalist 4-8 and Tech Apps 8-12. Over the course of the last 16 years I have been an educator. Fourteen of those years, I was a teacher in elementary and middle school settings. During my first year as a teacher (1998) I taught a 5th grade self-contained class of twenty students in Oklahoma. The school of which I was assigned was a Title I school, meaning a high percentage of the students qualified for the free/reduced lunch program. This posed a problem when attempting to generate technology driven lessons, as many students had no access to technology and smart mobile devices were not as widely owned as they are today. Still I solicited neighboring businesses for discarded computers, called software companies for donations, and used much of my own equipment from home to create a learning environment that was not solely paper-pencil driven. I wanted to create an atmosphere where students took ownership of their learning and created or built new knowledge from project-based learning.

Although, educators knew this idea, many veteran teachers thought of my strategies as odd or admitted to not understanding the equipment and had not desire to learn how it could enhance the lessons being taught. At the time, standardized testing was still a part of the public school system but the district I worked for, Union Public Schools, did not dictate that each teacher teach the same way at the same time using the same verbiage. This afforded me the freedom to teach in a way that was creative and fun. I felt, and still do feel, that if I was having fun learning and teaching then my students would too.

Over the course of 5 years I taught the 5th grade self-contained class by finding project-based ideas from which my students could build new knowledge. For Language Arts my
students created a school-wide newspaper. During Math my students would build objects or compete in edutainment games such as Math Blaster for extra credit. During Social Studies included a student ran daily broadcast where students not only reported school events but local and national current events as well.

While teaching so many technology based lessons, I decided to purse my Master’s degree in Telecommunications Engineering. My thought was that I would like to know how to set up a networked system within my school to work with schools across the globe. With the knowledge I would acquire through my Master’s degree I would meld it into my knowledge as an educator to create a system that would enhance learning throughout school districts.

For my master’s thesis project I set up a system which would allow my students to take a Spanish class with a group of students at another school in the district. Our school did not have an on-site Spanish instructor and as our Spanish speaking population grew at rapid rates I asserted that this would be an important skill. The students were very excited to work with other kids outside of the brick-and-mortar classroom they new as their sole learning environment. The project was a success in achieving increased student engagement and interaction but also had room for improvement. At the time it was the early 2000s and technology was nearly as fast so there were often lags in communication or pixelated images of the other students. This distracted from learning and the students did not gain as much from the project as I had hoped.

One thing I noticed when I moved to Texas in 2004 was the school I was assigned to in McKinney ISD was drastically different than the school from which I came in Oklahoma. The district overall was more affluent but this particular school was located in a high socio-
economic neighborhood and in many cases students had access to the most current technology on the market. However, this did not have any effect on the students when it came to learning. Often times the students that had access to the technology at home only had a limited knowledge of how to utilize it. I noticed that when I assigned computer-based projects students often struggled at basic operation of the machine. It was then that I concluded that socio-economic advantages did not have any bearing on students’ knowledge or skill base.

In 2005, I transferred to teaching technology classes at the middle school level in Frisco ISD. I was assigned to teach video production and graphic arts. I was to teach the students how to use Final Cut and Photoshop of which I had no working knowledge of either. Papert suggests, a teacher should not be afraid to learn with the students. I learned as much as I could before school started and admittedly to the students told them I was not just a teacher to them but I would also be a learner as the year progressed. A teacher, especially one that teaches technology, should understand that they are always placed in the role of learner in addition to facilitator of learning.

As the researcher in this case study my personal pragmatic experiences came into play while looking at the data. I assimilated the new knowledge that appeared from the research to the old knowledge I already had as a classroom teacher. Although every attempt was made to separate my old experience and knowledge I feel that it is impossible to be completely unbiased as a researcher that was a pragmatist for so many years.

During my journey of earning my PhD I have been exposed to many professionals worldwide. Speaking on research I have done in Spain and Germany afforded me an opportunity to network with other professionals from other countries. Faculty in the Learning Technologies
department have guided my through my search to narrow and polish my own theory of
learning. Their ideas and suggestions in addition to my own research have shaped my
perspective on how education should look globally, not just America. It is my professional goal
to continue speaking globally at conferences or as an invited speaker so that I may share any
knowledge I have and learn from others simultaneously.
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