The Potential of Serious Games for Teaching High School Construction Technologies: A Case Study

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In Partial Fulfillment of the Requirements For the Degree of Master of Education
In Educational Communications and Technology
In the Department of Curriculum Studies
University of Saskatchewan
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Abstract

The field of education is constantly evolving, and digital technology in the classroom is commonplace and includes the utilization of films, internet, computer aided instruction, educational video games, presentation software, edutainment, digital photography, cinematography, and computer aided drafting. As technology has advanced, so have the opportunities for its use in the classroom. This is particularly the case with serious games.

“Serious games are generally defined as games whose primary intent is training or learning with definable learning goals, instead of being primarily intended for entertainment” (Hartz & Stern, 2008). Closely related to educational video games and often used synonymously, serious games commonly incorporate simulations and role play. The design and focus of serious games are being recognized by a widening array of audiences including educators of primary and secondary education.

Much of the past research on serious games has focused largely on supporting the use of digital games in education. Little research has been done not only on why and how the games are effective, but also on how to incorporate the games into the curriculum (Becker, 2007). As the availability of serious games increases, it is important to build studies around specific games, exposing their potential and usability for specific curricular areas.

This case study utilizes the serious game *Building Homes of Our Own™*, which has been created to educate students on the processes of planning, building, and selling a house. The study involved 18 Grade eleven students who were enrolled in Practical and Applied Arts (P.A.A.) and were engaged in the construction portion of their course.
Three methods of data collection were used to explore four basic research questions:
1) How well does the game teach curriculum objectives? 2) How well does the game facilitate higher-order thinking? 3) What kind of environment is created by serious gaming in teaching construction? and, 4) What do students think about using serious games in the classroom? Research methods included the administration and evaluation of pre- and post-tests, administration and evaluation of critical thinking questions, direct observation of the serious gaming learning environment, and the utilization of a focus group interview.

Findings in the study provide important information that serves to answer the main question addressed by this study, namely, what is the potential of serious games for teaching high-school construction technologies? The findings report how effectively the serious game *Building Homes of Our Own™* supports Saskatchewan’s construction curriculum objectives. Findings also include relevant information on a variety of critical-thinking skills learned as a result of playing this particular serious game. The researcher and his assistant made significant observations of the learning environment created by this serious game, and, finally, the students provided important information regarding the strengths and weaknesses of using *Building Homes of Our Own™* and serious games in general, for learning in the context of P.A.A.
Acknowledgements

In the process of completing a Masters degree one needs guidance, encouragement and support from a multitude of people. Primarily I would like to thank my wife for her love, patience and understanding. Thank you for your encouragement and for taking on all those extra responsibilities when I could not be around. To family and close friends, thank you for showing me good work ethic and providing me with an ear to bounce ideas off of.

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Special thanks to Dr. Dirk Morrison, my advisor. On many occasions you went beyond your call of duty to ensure the success of this study. Your advice, suggestions and meticulous edits were extremely helpful and insightful.

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Chapter I

Introduction

_Serious games_ are digital games with a purpose beyond entertainment, including but not limited to, games for learning, games for health education, and games for policy and social change (http://seriousgames.msu.edu). Closely related to educational video games and often used synonymously, serious games are commonly created to incorporate simulations and role play. Whereas educational video games traditionally target the primary and secondary educational system, serious games are being developed for a wide array of audiences requiring some degree of training. Serious game initiatives are growing worldwide with the objective being to develop games that are educational, intriguing and that potentially encourage high-order thinking skills. _Serious Games Canada™, Serious Games Europe™_ and the _Serious Games Initiative™_ are just a few examples of organizations and initiatives that have been established around the world to support and facilitate the growth of serious games.

The underlying goal of serious games is to improve and to provide new opportunities for learning. Serious games have proven to increase motivation and student’s desire to learn (Van Eck, 2006). Historically, educational video games used in the classroom were simple point and click games such as _Math Blaster™_ and _Oregon Trail™_ that offered very little interaction and typically addressed the lower levels of Bloom’s Taxonomy (Rice, 2007), namely, knowledge, comprehension and application but not so much the higher order thinking levels of analysis, synthesis, and evaluation. Today gaming technology has advanced and now allows students to develop these
higher-order thinking skills from game play (Rice, 2007). It is this author’s opinion that we have a responsibility as educators to recognize and to harness the power of serious games and to use them to effectively educate our students.

While there is a growing interest in the area of serious gaming as applied to general education, there is very little research in the area of serious gaming specifically applied to teaching the trades. As discussed in Chapter Three, recent studies on digital games focused largely on nine main areas including: cognitive and curriculum aspects, aggression, physical health, equity, culture and stereotyping, designing digital game based learning environments, and motor skills, simulation and tracking tasks (VanDeventer, 2002). No research could be found relating to using serious games for teaching the trades in a high-school environment.

Although there is a paucity of research on serious games as applied to vocational and technical education, there may be significant benefits to consider. For example, it would be an excellent learning opportunity for an educator of high-school construction technologies to take his or her class on a field trip to a construction site. However, realistically, this may prove to be very difficult as the construction site may be too far away, the weather may be poor, and there may be liability/insurance obstacles, any of which may prevent a class from being physically taken to a construction site. Alternatively, exposing your construction class to a virtual construction site would offer a predictive, structured yet malleable learning environment that may even prove to be superior to the physical environment. For example, in a virtual environment, students may be able to ask specific questions of a variety of virtual trade professionals involved in the simulated construction process. At the click of a mouse students could have access
The purpose of this study was to investigate the potential use of a serious game in teaching construction technologies. The study was comprised of a case study in which the game *Building Homes of Our Own™* was implemented into the construction portion of a Grade eleven Practical and Applied Arts (P.A.A.) survey course. *Building Homes of Our Own™* is a program developed for the National Association of Home Builders’ (NAHB) ongoing educational initiative. The program is available free of charge to members of home building associations and classroom educators in the United States of America. It is accompanied by a 190-page teacher’s guide and a 20-minute self guided tutorial to help with the successful implementation of the program.

Aims of the Thesis

The goal of this research was to study the educational potential for using a serious game, specifically, *Building Homes of Our Own™*, as a teaching tool in a high-school construction class. To determine the educational potential of the game, a case study method was used to observe the learning environment facilitated by the game, to test whether students had learned information that coincides with curriculum objectives, to investigate the game’s ability to teach higher-order thinking skills, and, to examine student perceptions on the use of a serious game for teaching construction technologies.
Data collected through pre- and post-tests, observation of the learning environment, and the utilization of a focus group have been used to seek out answers to the following research questions:

1. Can the serious game *Building Homes of Our Own™* be used to successfully teach construction curriculum objectives?

2. What type of learning environment was created by using the serious game *Building Homes of Our Own™* as a learning tool for high-school construction technologies?

3. Did the serious game *Building Homes of Our Own™*, applied to teaching high-school construction technologies, support a learning environment that facilitates high-order thinking?

4. What are these high-school student’s perceptions regarding the integration of the serious game *Building Homes of Our Own™*, and serious games generally, for learning construction technologies?

**Delimitations**

This study focused on the potential for the use of the serious game *Building Homes of Our Own™* in teaching construction technologies. To successfully complete this research in a reasonable time frame and with only a limited budget, this study had specific delimitations. First, this study utilized a convenience sample of Grade eleven students who would normally enroll in this class. There were no restrictions put on the enrollment criteria for this class which means that the class size and gender ratio was consistent to how it would normally have been for this class. Only students who returned
the parental assent forms partook in the study. One student chose not to participate in the study for personal reasons. This did not adversely affect the size of the sample and therefore did not significantly alter the data collected by this study. Students in this course spent two and a half months in the shop setting and two and a half months in the classroom. The length of the research was therefore, limited to the time allowable for this particular topic and location where learning was taking place. The computer lab consisting of computers donated by local schools and businesses was specifically set up for this case study. All computers were tested prior to the research, to ensure they were capable of running the game adequately. Students may also have exerted less effort because there was no mark being assigned for their participation in the game. Students, however, were encouraged to take the study seriously as they were informed that the next portion of their course would deal with similar information found in the game and would be evaluated.

**Limitations**

There are a number of limitations that should be noted specific to this study. First, the foundation for this research has been structured within a case study methodology. The case study consisted of a convenience sample of 18 Grade eleven students partaking in the construction section of their Practical and Applied Arts class. These 18 students made up only a small portion of all students enrolled in Grade eleven high-school construction classes in Saskatchewan at the time of the research. Second, this study utilized the game *Building Homes of Our Own™*. Findings are therefore limited to this particular serious game. Third, the game *Building Homes of Our Own™* was primarily created for the
United States education system. To ensure the game was applicable to Saskatchewan, Canada’s curriculum, a critical analysis was completed prior to the study.

Assumptions

A number of assumptions were made by the researcher during this study. First, it was assumed that students had an understanding of the basic operation of a computer. Second, it was also assumed that students were truthful on interim and test questions and focus group comments. It was also assumed that problems with computer equipment would occur causing some degree of disruption within the study.

Definitions of Major Terms

The following terms are used throughout this thesis and it is beneficial for the reader to become familiar with them prior to examining this study.

<table>
<thead>
<tr>
<th>Video Games:</th>
<th>Traditionally this term was used to describe digital games played primarily on home consoles. Today it has been broadened to include games played on personal computers and handheld devices.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serious Games:</td>
<td>“Serious Games are generally defined as games whose primary intent is training or learning with definable learning goals, instead of being primarily intended for entertainment. Such games are, by definition, outside the “real world” bounded by time and space, but are particular about the recreation of the “real world” as a design feature. In fact, the “real world” aspect, or authenticity, is a design feature that sets Serious Games apart from most entertainment games” (Hartz, &amp; Stern, 2008).</td>
</tr>
</tbody>
</table>
| Edutainment: | The act or process of educating or being educated while being entertained. Edutainment activities “often lack the features associated
with games, such as following rules and winning or losing” (Alessi & Trollip, p.270, 2001). Edutainment products also “do not cover topics as completely or in as great depth as do those methodologies for older learners” (Alessi & Trollip, p.148, 2001).

**Simulation:**

“Many simulations do not fall neatly into just one category but are a synthesis of more than one type” (Alessi & Trollip, p.215, 2001). In a game context a simulation is a digital imitation of something real that has game characteristics such as competition, rules, winning and losing.

**Avatar:**

Certain digital games require the player to create an avatar. An avatar is a player’s virtual representation of him/herself. This may be a two or three dimensional representation depending on the type of digital game.

**Commercial Off The Shelf (COTS):**

COTS games are the most readily available video games to consumers. In some instances these games may be used for educational purposes, however, they are primarily targeted towards the entertainment industry.

**Digital Game Based Learning (DGBL):**

DGBL is the learning that takes place from playing any type of digital game. The objective of DGBL is to coordinate subject matter with game play encouraging retention and application of learned material to the real world.

**Bloom’s Taxonomy:**

Benjamin Bloom recognized three domains of learning; Cognitive, Affective and Psychomotor. This study utilizes Bloom’s cognitive domain and its six major categories including; knowledge, comprehension, application, analysis, synthesis and evaluation.

**Net Generation:**

Also referred to as “generation z”, the net generation are typically the offspring of generation x and are in grade school or younger.

**Virtual:**

In this document the term virtual refers to “virtual world” as it is commonly used when describing digital games. A virtual world is a
computer simulated environment that creates a new world or recreates the real world. A virtual world consists of two or three dimensional representations that interact in a two or three dimensional environment.

**Implications of the Research**

Questions such as “Why do we need to learn this?” or “When are we ever going to need this?” are quite familiar to an educator’s ear. Motivating students to learn is often challenging. Educational games in general and certainly digital games in particular, seem to have a “built in” motivation to learn. For example, learning map reading skills is likely made more interesting by locating secret treasures using an in-world serious game scenario rather than simply by reading a textbook about longitude and latitude. Many would claim that serious games motivate students primarily through the drive of curiosity. According to Keller (1997), Driscoll (2005) and Alessi and Trollip (2001), motivation through curiosity is achieved with the use of competition, fantasy, goal setting, problem-based situations and the hands-on approach of educational digital games.

To date, digital gaming research has focused largely on supporting the use of digital games in education. Very little research has extended to why and how digital games are effective and to how they can be best integrated into a curriculum (Becker, 2007). It has only been within the last ten to fifteen years that technology has progressed to permit complex games that have the potential to promote high-order thinking skills. Digital games such as *Civilization IV™* and *Rise of Nations™* are two such examples of commercially available games that potentially promote higher-order thinking, as are *Global Conflicts: Latin America™* and *Chemicus: Journey to the Other Side™* which
have been created directly for educational purposes. This research study is unique in that it studies the application and evaluation of one of the few serious games developed specific to construction technologies, Building Homes of Our Own™ within the context of secondary P.A.A. education.

Organization of the Thesis

This thesis is comprised of six chapters. Chapter I outlines the purpose of the research, identified delimitations, limitations and explained assumptions of the study, provides important definitions that will be used in later chapters, and states implications of this research. Chapter II reviews literature relevant to serious gaming in education, as well as additional theoretical and foundational literature relevant to this thesis. Chapter III discusses the methodology used in the study. Chapter IV presents the findings obtained by the research study. Chapter V provides an analysis of the findings, and Chapter VI includes recommendations and implications for further research and practice as well as summarizing final conclusions drawn from the study.
Chapter II

Review of the Literature

Introduction

Twenty-first century children are spending an ever-increasing amount of time playing digital games. According to a 2008 Pew Internet & American Life Project, “97% of teens ages 12-17 play computer, web, portable, or console games” (pg. 2). Historically, many educators have realized the benefits of using digital entertainment for learning; edutainment and simulation products such as Math Blaster™(1987), Reader Rabbit™(1986) and Oregon Trail™(1985) have been commonly used in the education system (Alessi & Trollip, 2001). Since these earlier educational digital games, technology has improved to allow for more complex digital games to be developed and employed; with the development of complex games, more educational potential is being realized by educators. Numerous educators and educational theorists (Gee, 2007; Prensky, 2007; Shaffer, 2008; Squire & Jenkins, 2003) have focused attention on the educational potential of digital games. According to Van Eck (2006), “the combined weight of three factors has resulted in widespread public interest in games as learning tools: the ongoing research conducted by digital game-based learning (DGBL) proponents, today’s “Net Generation,” who have become disengaged with traditional instruction, and the increased popularity, generally, of digital games for entertainment” (pg. 1).

This literature review will provide a general understanding of serious games as they apply to education. It will also focus on a review of relevant research addressing the motivational characteristics of serious games, how serious games can promote higher-
order thinking skills and it will explore teaching practices and strategies for implementing serious games into the classroom.

A Note on Digital Game Research

Digital game research in education commonly utilizes both commercial off-the-shelf (COTS) and serious games. Although this literature review focuses primarily on serious games, there is a considerable body of research completed on digital games that are not directly created for education and learning, but that have been applied to educational settings. This research is often applicable to the research of serious games and at times will be included in this literature review. Where research has been directly related to education and learning the term serious game will be used. For all other research including digital games, electronic games, video games, computer games, and so forth, the general term digital game will be utilized.

Serious Gaming

Digital games, as a general over-arching category, can be defined as electronic games including interaction mediated through electronic hardware such as a computer or gaming console where the application of game rules are applied automatically through the electronic hardware (Dipietro, Ferdig, Boyer, & Black, 2007). Digital games may be created to be non-educational or educational. Non-educational games are created for entertainment without the direct purposes of education in mind. These games consume the majority of the gaming market and are referred to as COTS, or commercial off-the-shelf games. Although they may not directly be designed for educational purposes, many
of these games can indirectly educate players. Games such as Civilization™ and The Sims™ are classic examples of COTS games that indirectly educate and may be very relevant to a curriculum. For example, according to Shaffer (2006), Civilization™ “is a game based on historically accurate model of advances in technology, religion, and the arts, and as players master the game system, they can begin to ask and to play out historical experiments” (p. 39). These games are transformed for educational purposes when used for a specific aim, to learn particular things, and to develop certain strategies and/or abilities (Gros, 2003; Squires, 2004). Currently, the general use of digital games and game technologies for educational purposes, beyond solely for entertainment, is collectively referred to as serious games (Sawyer, 2007). Serious games may be used for primary or secondary education but may also be intended for audiences outside of the school system (e.g., professional development, adult education, training, etc.).

Gros (2007) claims digital games can generally be placed into seven distinct categories. Note that any particular game may fall neatly into one category, or fit a combination of two or more categories.

<table>
<thead>
<tr>
<th>Action games (also called platform games)</th>
<th>These games are reaction based; the majority of earlier games tended to fall under this category. Examples include Doom™, Super Mario™ and Half Life™.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adventure games</td>
<td>The player solves a number of tests in order to progress through a virtual world. Examples include Myst™ and Riven™.</td>
</tr>
<tr>
<td>Fighting games</td>
<td>These games involve fighting against computer-controlled characters or those controlled by other players. Examples include Mortal Combat™ and Virtual Fighter™.</td>
</tr>
<tr>
<td>Role-playing games (RPGs)</td>
<td>Human players assume the characteristics of some person or creature. Examples include EverQuest™, Oberin™, and World</td>
</tr>
</tbody>
</table>
The player has to succeed within some simplified recreation of a place or situation to achieve a particular goal. Examples include Sim City™ and The Sims™.

These games are based on sports. Madden NFL™ and NASCAR®.

These games recreate a historical or fictional situation to allow a player to devise an appropriate strategy to achieve a goal. Examples include Civilization™ and Roller Coaster Tycoon™.

Serious games can incorporate a multitude of game categories depending on their design.

Players of the serious game Pulse!!™, for example, assume the role of a doctor who interacts in a virtual environment with simulations of operational health-care facilities, procedures and systems. Restaurant Empire™ is another example where a number of game genres are utilized. In this game the player assumes the role of a restaurant owner in a simulated urban environment who encounters various role-playing and strategy scenarios throughout the game.

Educational Research on Digital Gaming

Digital games have been around for over 30 years. They have become highly interesting to educators and researchers since their sophistication has improved considerably over the last decade (Rice, 2007). In 2002, the Serious Games Initiative was founded in Washington, D.C. Since its inception it has been instrumental to exposing the commercial, independent and academic world to the innovations and ideas of the gaming community. Perhaps due to the notion that serious games are a relatively new
phenomenon, there is very little research that moves beyond simply supporting the use of such games. Becker (2007) states:

“Even teachers who have a strong desire to use games for learning have their work cut out for them. There are few places to turn to find out about which existing games can be used effectively, even fewer resources for finding out how to use these games once they have them, and fewer still if they wish to build their own” (p. 1).

Van Eck, (2006) further supports needed research in these areas: “We are ill-prepared to provide the needed guidance because so much of the past DGBL research, though good, has focused on efficacy (the message that games can be effective) rather than on explanation (why and how they are effective) and prescription (how to actually implement DGBL)” p. 16.

Recent studies completed on digital games focused largely on nine main areas including:

<table>
<thead>
<tr>
<th>Cognitive and curriculum aspects</th>
<th>Evans, 2007; Boot, 2007; Hsiao, 2007; Blunt, 2006; Smith, 2006; Mehmi, 2006; Ruud, 2006; Wainess, 2006; Zaparyniuk, 2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggression</td>
<td>Bacchus, 2007; Gonzalez, 2007; Carnagey, 2006; Pusateri, 2006; Mahood, 2006; Giumetti, 2006</td>
</tr>
<tr>
<td>Physical health</td>
<td>Byas, 2006; Lee, 2006; Barrick, 2006; Williams, 2006</td>
</tr>
<tr>
<td>Equity, culture and stereotyping</td>
<td>Gillentine, 2007; Mou, 2007; Morowitz, 2007; Hackbarth, 2006</td>
</tr>
<tr>
<td>Designing digital game based learning environments</td>
<td>Leibovitz, 2007; Buchanan, 2006; Squire, Giovanetto, Devan &amp; Durga, 2005</td>
</tr>
<tr>
<td>Gender</td>
<td>Hue, 2007; Feng, 2006; Beedle, 2004</td>
</tr>
<tr>
<td>Addictive behavior</td>
<td>Waggoner, 2007; Silverman, 2006</td>
</tr>
<tr>
<td>Motor skills, simulation and tracking tasks</td>
<td>Belchior, 2007; Boot, 2007</td>
</tr>
</tbody>
</table>
VanDeventer (2002) found very similar research trends in the mid to late 1980’s and early to mid 1990’s. This further supports the need for research to move past the traditional focus on efficacy and into the examination, analysis and implementation of specific gaming applications.

**Educational Theory and Serious Games**

Educational theorists have provided educators with an appreciation of how people learn. Theories of learning and instruction have helped educators develop methods to more efficiently and effectively educate students. Learning theories ranging from behaviorism to constructivism indicate that teachers educate, and students are able learn, through a variety of methods. New theories are continuously being developed to address the changing needs and nature of the educator, of learners, and of society. Today the Internet, television, cell phones, movies, mp3 players and digital games have all become main-stream communication and information technologies in our society and are, for most, a part of everyday life.

It is felt by many that even as the developed world has changed and incorporated with the digital world, little has changed within our education system: “How will educational technologists respond to a generation of students who, raised on interactive games, expect the same kinds of interactive experiences from their educational media?” (Squire, Giovanetto, Devane, & Durga, 2005, p.34). Educational theorists are now faced with the changes and challenges that modern digital technologies present.

Numerous authors support the idea that serious gaming fits well into an array of existing instructional theories. According to Van Eck (2006), there are many areas of
research that account for how and why games may be effective learning tools. These include: anchored instruction, feedback, behaviorism, narrative psychology, and a host of other cognitive psychology and educational theories and principles. VanDeventer (2006) states “Newer instructional theories, such as, social learning theory (Vygotsky; 1978, Bandura, 1977); self regulation, motivation, and incidental learning (Keller, 1987; Reiber, 1991); multiple intelligence theory (Gardner, 1983) and experiential learning (Kolb, 1984) lend themselves quite well to the design of serious gaming” (p. 28). According to Prensky (2007), one of the main characteristics of digital game based learning is that it creates a learner-centered, interactive approach to education. Prensky (2007, p.157) further suggests that interactive learning techniques have already been used in digital game design and include:

- Practice and feedback
- Learning by doing
- Learning from mistakes
- Goal-orientated learning
- Discovery learning and “guided discovery”
- Task-based learning
- Question-led learning
- Role Playing
- Coaching
- Constructivist learning
- “Accelerated” (multisense) learning
- Selecting from learning objects
- Intelligent tutoring

Serious gaming has also been connected with constructivism. Constructivist theory rests on the assumption that knowledge is constructed by learners as they attempt to make sense of their experiences (Driscoll, 2005). Dickey (2003) found that three-dimensional virtual world scenarios which are commonly utilized in serious games, granted students control of their learning, allowed for active participation in learning
activities and fostered collaboration through discourse with peers. According to Driscoll (2005), these are very much the characteristics of constructivist pedagogies. Serious games that include simulation, role play and adventure such as *Peacemaker™* create a constructivist learning environment (Namee, Rooney, Lindstrom, Ritchie, Boylan & Burke, 2006). Inspired by real events in the Israeli-Palestinian conflict, players of *Peacemaker™* assume the role of Israeli Prime Minister or the Palestinian President and must bring peace to the region before their term in office ends.

Within serious gaming research, the motivational characteristics of serious gaming are regularly discussed. Motivational characteristics appear to be key factors for engaging students in a wide array of digital game learning activities. This topic also aids in forming the underlying argument proposed for the potential use of serious games in technical and vocational education and is discussed in the next section.

Motivating Characteristics of Serious Games

Serious games can effectively motivate learners in educational environments (Alessi & Trollip, 2001). As mentioned earlier, motivating characteristics of serious games may include but are not limited to: fun, play and games, competition, fantasy, goal setting, problem solving, hands-on experience, and interaction/communication.

Fun, play and games

According to Meriam-Webster’s online dictionary, a game can be described as an activity engaged in for diversion or amusement through a physical or mental competition conducted according to rules with the participants in direct opposition to each other.
(www.meriam-webster.com/dictionary/game). Until the end of the nineteenth century, games had been associated with entertainment, but with the influence of John Dewey, games began to play a significant role in the teaching methodology (Gros, 2003). Dewey (1938), Piaget (1951) and Vygotsky (1978) share a common position that play functions as an important part of learning. According to Piaget, (1951) for example, it is through play that children construct a sense of order and meaning out of their environment. The unstructured environment of play however, may lack the order and meaning required in an educational environment. Prensky (2007) suggests that games need to be harnessed to unleash the educational powers of fun and play. Today, games, both paper and digitally-based are being created specifically for structured educational play.

Prensky (2007) lists three key motivators found in digital games, namely, fun, play and games. He states that the principle role of fun in the learning process is to create relaxation and motivation. Relaxation enables a learner to take things in more easily, and motivation enables them to put forth effort without resentment (Prensky, 2007). Both fun and play, however, have the disadvantage of being somewhat abstract, unstructured, and hard to define concepts (Prensky, 2007). But a more formal and structured way to harness (and unleash) all the power of fun and play in the learning process exists – the powerful institution of games (Prensky, 2007). “Games are a logical way to incorporate cooperative learning activities as well as competition because people are quite used to playing team games (such as many sports) with elements of both cooperation and competition” (Alessi & Trollip, 2001, p. 206). However, these authors also caution that “learners may become so engrossed in winning the game that they are distracted from the learning objectives” (2001, p. 207). It is therefore important that games are designed so
that winning the game and accomplishing the learning objectives are tightly linked (Alessi & Trollip, 2001). Linking learning objectives to game objectives is a defining characteristic of serious games. In Age of Ecology™ for example, the games' goals are directly related to the learning objectives which are to act as a regional planner and to learn about the productive capacities of the region and the principles of environmental sustainability.

With the utilization of serious games for learning, students have fun through play and games. An underlying benefit of serious game play is subsequently the acquisition of important knowledge through accomplishing game goals.

**Competition/Challenge**

The principles of competition can be associated with a variety of topics. This section applies competition as it is relevant to playing games, either digital or paper based.

Alessi & Trollip (2001) suggest that competition is perhaps the characteristic most strongly identified with games. In review of the literature, Van Eck and Demsey (2002) identify a considerable body of research that support conflicting results, some demonstrating positive results of competition and a similar number reporting negative effects, and some resulting in no significant difference. Importantly, competition can be both a motivating or de-motivating experience for players. According to Dearden (1972), competition is de-motivating when peers experience a loss of self-esteem generally occurring when rivals glorify in others' failures. On the other hand, competition is motivating when there is some chance of relative success (Dearden, 1972). According to
Alessi & Trollip (2001), competition in educational contexts is relatively difficult to successfully implement and monitor as individual feelings and class morale may be at stake. Alessi & Trollip (2001) state “The problem with competition among learners is although it serves as a powerful motivator for learners who do well, it may be a punishment and embarrassment for those who do poorly” (p. 205). In a competitive situation, individual players attain their goals only when other participants do not. This is why competition is recommended among groups as it also fosters cooperation (within a group) and because groups can be more evenly matched than individuals (Alessi & Trollip, 2001). Competition is also recommended and may be successfully implemented through the computer, oneself and the clock (Alessi & Trollip, 2001).

**Fantasy**

A strong motivator of learning in adults and children alike is curiosity (Driscoll, 2005). One way of sustaining curiosity involves fantasy and this can be provided in serious games. Levine (2006) states “Many fantasy and role-playing titles have very rich, detailed narratives that exist behind the action of the game. Whole worlds are created, characters are created with back-stories, and completed tasks lead to a resolution that makes sense for those characters in that world” (p. 12). Serious game players often assume a role within their virtual world where they may have an occupation, operate tools and equipment, explore new places, perform cognitively difficult tasks (e.g., problem solving) and make important decisions related to game play. “The use of fantasy in learning entails providing learners with a meaningful context for learning that is easy to augment with their imaginations. The context is meaningful to the learner in the sense
that it offers a very personal degree of fascination and intrigue” (Rieber, 1991, p. 320). Squire (2006) describes Civilization HI™ as an example of a digital game involving fantasy used to help capture and sustain curiosity. In Civilization HI™ game players rule a civilization from 4000 B.C. to present. The Initial goals of Civilization are to build cities, gather resources, engage in trade negotiations and wage war. These goals maintain player’s curiosity through fantasy; however there are a number of necessary educational tasks within the game needed to accomplish this goal. “Players might develop a new appreciation for the historical importance of the Gaza Strip or the Panama Canal or for the strategic importance of horses, particularly their absence in North America” (Squire, 2004, 138).

Goal Setting

Actively setting goals can be an important source of motivation (Bandura, 1977). As long as the learner is capable of performing the goal, setting more difficult goals tends to lead to greater persistence and better performance than setting easy goals (Locke, Shaw, Saari, & Latham, 1981).

Setting goals in digital games refers to the games’ goals and not the educational goals or learning objectives. This is an important distinction between digital games and serious games. In serious games an important aspect of game design is the relationship between the game goals (the nature of winning) and the learning goals (the nature of what is to be learned) (Alessi & Trollip, 2001). For example, in a hypothetical game situation, the goal of the game may be to fly a ship to the moon. A good peripheral learning goal may use mathematical formulas to guide the ship to its destination. In more complex
games, such as those that include simulations and role-play, goal setting may be put into place prior to playing the game or may be incorporated within the game. Consider the game *Supercharged!*™ developed at MIT to help students learn basic concepts in electrostatics. Squire (2006) states:

“In *Supercharged!*™ players enter a world of electrostatic charges and must lead a group of virtual classmates through levels that are matched to classic physics though experiments. Levels are designed to build players' intuitions about electrostatic forces and distance; players, attempting to go straight through the level and toward the goal, frequently hypothesize that the forces generated from each charge will negate one another or create a balance efforces. As players confront a variety of levels designed to elucidate this mathematical principle, they begin to intuit how electrostatic forces interact” (p. 7).

The games’ goal is to lead a group of classmates to safety while the peripheral goal is to learn about electrostatic forces.

**Problem solving**

Keller (1987) states that another way of sustaining curiosity may be activated by creating a problem situation that can be resolved only by knowledge-seeking behavior. Giving the learner problems to solve primarily facilitates application strategies because solving a problem requires the application of relevant knowledge and skill. Problem-solving also facilitates understanding and awareness of one’s own thinking and cognitive processes) (Alessi & Trollip, 2001). When teachers discuss problem-solving skills on the part of pupils, they anticipate pupils will become involved with thinking operations of
analysis, synthesis, and evaluation (considered as higher-order thinking skills) (Bosser, 1988).

Problem solving is the critical cognitive "engine" that drives a vast array of digital games. In fact, problem solving is one of the defining characteristics of digital games as players interpret rules and determine how to play the game. Subsequently, solving problems within the game is where the real potential for fostering problem solving skills and the complex relationship for learning takes place (Gee, 2007). In the game Geo-Political Simulator™ players take on the role of the president and face a plethora of decisions to make and problems to solve. Some of these include deciding on bills he or she may introduce or arranging meetings with the country’s influential personalities where negotiations and important problems need to be solved. Decisions made and problems solved within the game determine whether the player is a humanist president or a ruthless dictator.

**Hands-on experience**

Serious gaming allows students to learn by doing rather than by listening or simply observing. “One of the most rewarding (and subsequently, motivating) results of learning is to use the newly-acquired skills or knowledge” (Driscoll, 2005, p. 324). Sometimes it is very difficult or impossible to immediately use newly-acquired skills. This is where educational games, simulations in particular, may have powerful motivational effects. For example, when learning about housing foundations in construction, as mentioned earlier, it may be very difficult or impossible (depending on the time of year and the length of classes) to visit and explore a construction site. In a
comprehension and provides an environment for the exercise of metacognition (i.e., the game simulation however; it is possible to “leave” the classroom and explore virtual construction sites. One may even be able to ask virtual construction workers for information necessary to complete the game. In another example, the creators of *Global Conflicts: Palestine™* ask educators to imagine their game as a field trip to Palestine in the role of a reporter, allowing students to explore important issues in a fully immersive 3D world.

In many instances actual hands-on experiments or tasks such as observing plant cells through a microscope, practicing the proper grip when holding a baseball bat or correctly holding a paintbrush will be better suited to tangible manipulation. Serious games however, afford virtual hands-on opportunities that would otherwise not be possible for educators, or would be very difficult to implement. With the use of serious games in a school environment, students may be able to virtually go to another country and practice communicating a new language they have learned; they may go back in time to virtually experience or take part in history, or, they may practice their business sense by managing a virtual business. The list of virtual hands-on possibilities is extensive and is, likely only limited by the design and supporting technologies of the serious game.

*Interaction/Communication*

“Despite frequent public dismissals and indictments, digital games do constitute a complex and nuanced set of multi-modal social and communicative practices” (Gee, 2003, p. 32). In classroom-based serious games, students often socialize within their classroom to gain information or strategize ideas (Keeble, 2008). “Young people often
watch each other play, alternate watching and playing, and engage in continuous conversation about game play” (Hayes & Silberman, 2007, pg. 21). Networked computer environments can amplify students’ social and communication capabilities during game play. Increasingly, the internet allows games to become social experiences across vast distances (Stokes, 2005). The type and degree of communication depends largely on the type of game being played. Massively multiple online role-playing games (MMORPGs), for example, lend themselves very well to creating social environments. Dickey (2007) commenting on MMORPGs states:

“Typically a chat tool allows players to communicate during the gameplay experience. This allows players to request help, strategize on group quests, and socialize. Additionally, player-created websites often emerge where players offer advice or recount the strategies they employed in completing a quest” (p. 10).

Serious game players can also be connected within learning environments through computer networks. In these learning environments players can communicate via participating in discussion forums, posting news feeds, trading screenshots and exchanging game files in order to collaborate and compete (Shaffer, Squire, Halverson, & Gee, 2004). Players may also be able to virtually communicate through the use of avatars. As mentioned earlier an avatar is a player’s virtual representation of him/herself.

Currently the majority of serious games are being created as stand-alone games where there is little or no interaction with other game players within the game. Such stand-alone games can foster communication and interaction with peers playing alongside one another within the physical environment. An increase in communication and interaction can occur however, when computer networks are utilized by the games’
design. This is important as an increase in communication and interaction provides a gaming environment for all players to find answers, collaborate and contribute (Herz, 2002b).

**Accessing higher-order thinking skills with serious games**

Traditionally, the majority of educational games have been geared towards simple edutainment products used to teach skills in such subject areas as typing or math. Although these games have been highly successful, it is the speculation of this author that the focus for future serious game development will be for those that promote higher-order thinking skills. According to Rice (2007), the allure of importing the easiest elements of teaching, like worksheets, into a simple gaming environment is a strong one. An example of a simple edutainment product is *Math Blaster™* which offers digital worksheets for students to solve within a gaming environment. If teachers wish to address the upper levels of Bloom’s Taxonomy (Bloom, 1956) within computer gaming environments, more advanced products will be required. Rice (2007) offers a useful rubric for assessing cognitive potential in digital games (see Appendix A). It is important to note that game genre and design often characterize the game’s potential to teach higher-order thinking skills. Adventure and role-playing games, for example, may vary from simple knowledge and skill practice to teaching problem-solving skills, deductive reasoning, or “hypothesis testing” (Alessi & Trollip, 2001). On the other hand, it will likely be more difficult to incorporate higher-order thought processes in action or fighting games.

As technology improves and the serious game market grows, games that stimulate higher-order thinking skills are becoming more readily available to educators. A game
mentioned earlier, *Global Conflicts: Palestine™* is an example of a serious game that promotes higher levels of thinking. The objective of the game is to explore real-world environments and interact with people’s true stories. Playing an up-and-coming freelance journalist the player observes conflict from both sides and decides what story the media will tell. With quotes collected from the dialog in the game, the player’s goal is to create an article that is not biased and to have it published in a newspaper. The best exposure is then awarded to the story with the most news-value. In this way, the game challenges higher-order thinking skills such as analysis, synthesis and evaluation by challenging the player’s beliefs and ideas about the conflict.

*Teaching practices and strategies for implementing serious games into the classroom*

Becker (2007) claims “…with few exceptions, teachers are not using serious games in their classrooms for anything other than rewards given after the ‘real’ work is done” (p. 478). As serious games become more available to educators, it is important to understand how to successfully integrate them into the classroom. Serious game technology is a relatively new learning tool when compared to the relatively long history of education. It is to be expected that educators need more information on the potential and on the limits of serious games prior to implementing them into their lessons. They should also be comfortable in their ability to use the games effectively to enhance learning (Becker, 2007). Prior to integrating serious games into the classroom, Becker (2007) underlines the importance for educators to become familiar with both the selected game and the technology that is needed to run it.
Educators must consider many factors when choosing to use serious games in the classroom, the most important of which are the pedagogical strategies used in conjunction with student game play to provide maximum opportunities for student learning (Dipietro, et al., 2007). A review of the digital game based learning (DGBL) literature shows that, in general, educators have adopted three approaches for integrating games into the learning process: have students build games from scratch; have educators and/or developers build educational games from scratch to teach students; and integrate commercial off-the-shelf (COTS) entertainment games into the classroom (Van Eck, 2006). The second option most closely relates to serious game development. This is usually the most reasonable choice as game objectives are directly linked with curriculum objectives. Some COTS games can be used for educational purposes; however, more effort is required when linking game and curriculum objectives.

Once a game has been selected, educators must consider how to implement the game into the learning environment. Squire and Jenkins (2003) offer some suggestions for game implementation into the classroom:

“Small-scale games can be used for quick demonstrations in the midst of a classroom lecture; more ambitious games might be deployed over one or more class periods as central learning activities. Games can function as homework assignments, allowing students to work through challenges on their own. They also can be imagined as possible problems on a final examination, testing what the student learned by applying it to a specific task or activity” (p. 10).
Dipietro, et al., (2007) identify research that then supports following up the activity with a debriefing session and whole group discussions that reflect on the gaming experience.

Serious games may also be supplemented with a teacher’s guide. These guides can be very useful in providing specific teaching strategies for that particular game. For example, the 196 page teacher’s guide included with the game *Building Homes of our Own™* used in this study consisted of four sections relating to successful game implementation into the classroom. These sections included teaching strategies, pre-teaching strategies, teaching opportunities by game phase, and lesson starters organized by subject. In this case, the teacher’s guide proved to be an excellent resource revealing numerous teaching options for educators, something that is not usually included with COTS games.

**Summary**

This chapter provided a background to establish a general understanding of serious gaming, to review relevant research, including the motivational characteristics of digital games and how games can access higher-order thinking skills, and to explore teaching practices and strategies for implementing serious games into the classroom.

As digital games in general have evolved, their potential for educational applications and purposes has increased. At the same time, there is still a lot of groundwork to accomplish to realize the full potential of digital games (Gee, 2007). There is a growing body of research on the educational use of digital games, and increasingly, on serious games. Many of these studies promote the positive motivational
characteristics of these technologies. Although numerous studies have been completed, only recently have they begun to move beyond theoretically supporting the use of such games. Studies that provide concrete information on the success or failures of implementing serious games in educational contexts are the next step in this field of research. Further research in this area needs to include determining strategies for the optimal implementation of digital games into the classroom. Additionally, specific research is needed to address how best to integrate specific games into any particular current curriculum.

The analysis of this case study will address the successes, failures and, ultimately, the potential of the implementation of the serious game *Building Homes of our Own™* into a particular high-school construction technologies classroom. This will be accomplished by examining whether game play met curriculum objectives, by determining the critical thinking levels that the game challenged, by considering the learning environment established by the game and by analyzing students’ perceptions on the use of serious games in the classroom.
Chapter III

Methodology

The purpose of this case study was to evaluate the potential for the use of a serious game in teaching high-school construction technologies. The study involved 18 students enrolled in the construction portion of their Practical and Applied Arts class. This chapter describes the methodology used in this study, presents the research design, method of data collection, validity of the study and ethical considerations. The research program timetable has been included in Appendix B.

Research Design

For this research project a case study was conducted with a Grade eleven Practical and Applied Arts class. The Practical and Applied curriculum consists of eight main strands including Agriculture, Care and Hospitality, Communications, Design (Construct, Fabricate), Natural Resources and Transportation. The objectives included in this course were obtained from the Construction, Carpentry and Housing curriculum within the Design strand. It is important to note that the research took place within the school at which the researcher teaches; however, to eliminate conflict of interest, and/or any ethical concerns, the study was not conducted with one of the researcher’s own classes, but rather with a colleague’s class. A lab with 20 computer stations, all pre-loaded with the game Building Homes of Our Own™, was set up to facilitate the study. The study participants included 18 Grade eleven students enrolled in the Practical and Applied Arts class for the fall term running from September 4th of 2007 to January 18th of 2008. This course is designed to incorporate both hands-on and theoretical training in a variety of
areas of Practical and Applied Arts, including construction technologies. This study was conducted during the allotted time for the theory section of the course: the students partook in the case study during their 55 minute class time, twice weekly for one month, for a total of 13 sessions. The first session was used to explain the research project and administer student consent and parental assent forms (see Appendix C). For the second session, the students completed a written pre-test to determine prior knowledge of content areas addressed by the game Building Homes of Our Own™ (see Appendix D). At the beginning of session three, students were debriefed on the conduct and usage rules of the computer lab (see Appendix E). Sessions three through nine were allotted for game play. Session ten was used to administer the post-test (see Appendix D). The last three sessions were used to administer critical thinking questions (see Appendix F) and conduct a focus group interview. This research schedule (see Appendix B) ensured both the completion of level one of the game, and allowed adequate time to collect both quantitative and qualitative data for this study. During all sessions, the researcher and researcher’s assistant (a teacher colleague in P.A.A.) were involved in administering tests, asking questions, and gathering research data.

All students began the game Building Homes of Our Own™ at level one. Before or during the game play period, there was no additional and/or class instruction on the course topics the game covered. The following sections describe the three data collection methods used for this study including: administration of questions and tests, observation of the learning environment, and utilization of a focus group.
Data Collection

Through the use of questions and tests, observation of the learning environment, and the utilization of a focus group, data was collected during this case study to address four research questions. The following section lists each question and explains which methods of data collection were used.

Research Question #1: Could the serious game Building Homes of Our Own™ be used to successfully teach construction technology curriculum objectives?

Data was collected to address this question through the administration of pre- and post-tests (see Appendix D). Test questions were developed with consideration of Saskatchewan’s Practical and Applied Arts (P.A.A.) curriculum and the game’s objectives. It was anticipated that some students who were enrolled in the high-school P.A.A. course would have prior knowledge in the information that the game teaches. This would have affected the results of the final test the students were given and potentially lead to erroneous conclusions. Therefore, a pre-test was designed and administered to determine the prior knowledge of the students. This pre-test was identical to the post-test given at the end of the game play period. This allowed the researcher to qualify that test results indicate knowledge gained rather than prior knowledge.

Research Question #2: What type of learning environment was created by using a serious game as a learning tool for high-school construction technologies?

The learning environment was qualitatively observed during game play by both the researcher and researcher’s assistant (i.e., the classroom instructor, who played this
role in the research). According to Gall, Gall and Borg (2003), direct observation allows the researcher to observe the behavioral, social and material environment of the individuals being studied. Direct observation allowed both the researcher and the researcher’s assistant to examine and record data, in real time, and, upon reflection; regarding the nature of the learning environment.

An instrument designed to determine the type of learning environment created by the game was used to answer this second research question (see Appendix G). Each observer completed one learning environment observation instrument per seven gaming sessions for a total of thirteen completed forms. It is important to note that in order to collect as much data as possible, on day one of the game play sessions the researcher’s assistant was asked to focus only on the observation of the learning environment and leave startup procedures up to the researcher. This accounts for the thirteen rather than fourteen completed learning environment observation forms. The researcher and researcher’s assistant met briefly after each game play session to debrief and review each session’s learning environment findings.

Each learning environment observation instrument consisted of five areas of observation including: on task-behavior, collaboration, competition, problem solving, and engagement. The researcher and researcher’s assistant carried the instruments on clipboards at all times during the game play sessions so as to make available any and all observations occurring in real time. They made notes for each section and at the end of the session rated the level obtained by the students for each category from one to five according to the rubrics provided. It was emphasized that both the researcher and researcher’s assistant spread out in the room to gain as much data as possible. This helped
in recording numerous observations from different vantage points in the room. It also allowed the recorders more time to stay in one area and listen to conversations amongst players. At the end of each session the researchers and his assistant met briefly to discuss their observations.

**Research Question #3:** Did the serious game *Building Homes of Our Own™*, applied to teaching high-school construction technologies, support a learning environment that facilitates high-order thinking?

Seven questions were designed to determine the levels of cognition in which the game *Building Homes of Our Own™* facilitated (see Appendix F). During research sessions eleven and twelve students answered critical thinking questions. Six copies of question #1 and five copies of questions #2 through #7 were made totaling 36 responses if all students were present during sessions eleven and twelve. Over the two sessions students answered a total of two out of the seven questions. During session eleven, the seven questions were distributed randomly amongst the students. At the end of session eleven the researcher recorded which students answered which particular question. This list was used during the distribution of questions in session twelve to ensure that students did not answer the same question twice. One question was administered per class to allow students ample time to complete each question.

**Research Question #4:** What are these high-school student’s perceptions regarding the integration of the serious game *Building Homes of Our Own™*, and serious games generally, for learning construction technologies?
For the last session of the study, the class met in the gaming lab to discuss their serious gaming experience in a focus group setting. The utilization of a focus group “allowed participants to state feelings, perceptions, and beliefs that they would not express if interviewed individually” (Gall, Gall & Borg, p. 238). Focus groups are a useful way to understand how people feel or think about an issue, product or service. Questions asked during the focus group (see Appendix H) concentrated on the perceived strengths and weaknesses of using a serious game as a learning tool, comparisons to a traditional learning environment, whether the experience was positive or negative, what the students liked or disliked about learning by the use of a serious game, the information learned from the game, suggested changes to the game or gaming environment, and whether students would be open to using serious games for learning in the future.

Validity of the Study

In the following section, validity of the research design has been broken down according to research questions. Validity has further been subdivided into four different types; face validity, content validity, predictive validity and construct validity.

This study meets the needs of face validity as the case study is related directly to the research questions. The pre- and post-test, interim, focus group questions and learning environment observation instrument used for data collection were discussed with research supervisors to help determine whether they could likely measure what they intended to measure. This was accomplished through numerous meetings set up by the researcher.
**Research Question #1:** Could the serious game *Building Homes of Our Own™* be used to successfully teach construction technology curriculum objectives?

To determine whether game objectives corresponded with Saskatchewan’s construction curriculum a critical analysis was completed of the game *Building Homes of Our Own™* prior to the start of the study. The analysis consisted of studying the teacher’s manual, partaking in the self-guided tutorial, playing the game itself and cross-referencing learning outcomes with Saskatchewan’s construction technologies curriculum objectives. The critical analysis provided the researcher with data that positively linked game objectives with curriculum objectives. Test questions were then developed that correlated with the game and the curriculum ensuring good content validity. “Content validity is the extent to which inferences from a test score adequately represent the content or conceptual domain that the test is claimed to measure” (Gall, Gall & Borg, 2003, p. 621).

Test scores were validated with the use of *predictive validity*. When a researcher administers a test, obtains a criterion measure on the same subjects at a later time and computes a correlation, he is studying *predictive validity* (Cronbach & Meehl, 1955). To collect data for this research question an identical test was administered before and after the students’ game play period. The first test, labeled pre-test, was used to set the criterion with which to compare the second test or post-test results. Using identical pre- and post-tests also supported the fact that knowledge was gained from game play and data collected was not contaminated by student’s prior knowledge.
Research Question #2: What type of learning environment was created by using a serious game as a learning tool for high-school construction technologies?

In this study direct observation of the learning environment was utilized so as to be as unobtrusive as possible. “In some instances observation methods allow for more accurate data” (Gall, Gall & Borg, p. 254). In this study it would be more accurate for researchers to observe the learning environment rather than have students report on it because student reporting would interrupt and ultimately affect the environment. Questioning students on the learning environment directly would also likely make students aware of the data that researchers are collecting and may encourage them to alter their behavior within the lab.

Research Question #3: Did the serious game Building Homes of Our Own™, applied to teaching high-school construction technologies, support a learning environment that facilitates high-order thinking?

A series of questions were designed to evaluate levels of critical thinking, specifically, to determine whether playing Building Homes of Our Own™ in high-school construction technologies supports learning that facilitates high-order thinking. These questions were designed using specific guidelines (see Appendix I) to ensure good construct validity. “Construct validity is the extent to which inferences from [question] scores accurately reflect the construct that the [assignment] is claimed to measure” (Gall, Gall & Borg, 2003, p. 621).

The student’s written responses were evaluated according to criteria set by the researcher. A sample response for each question was developed as a guide for evaluation.
These guides included key information that was necessary in student responses.

It is important to note that the administration of the critical-thinking questions occurred after the post-test was administered so as not to affect the post-test results. This was necessary to ensure that data collected from the post-test was information that students learned only from playing the game and not from answering critical-thinking questions that encouraged additional thought and reflection by students in specific areas.

Research Question #4: What are these high-school student’s perceptions regarding the integration of the serious game Building Homes of Our Own™, and serious games generally, for learning construction technologies?

Focus group questions were created to understand what high-school student’s perceptions were on the integration of the serious game Building Homes of Our Own™ for teaching construction technologies. The focus group took place in the familiar setting of the gaming lab used for the majority of the study. This environment was chosen to help create a relaxed, non-threatening environment where students could easily reflect on their serious gaming experience. Questions were phrased and sequenced so that they were easy to understand and logical to the participants. The opening questions were designed to help create a relaxed atmosphere among focus group participants. As questions progressed they slowly become more in-depth and encouraged extra thought and reflection. Sufficient time was given and all students were encouraged to be involved and answer focus group questions. The moderator was also aware that group discussions often veered off topic. In this case, the moderator was prepared to steer off-topic discussions back on track. In focus groups, respondents can sometimes feel peer pressure
to give similar answers to the moderator’s questions (Krueger & Casey, 2000) so when consensus was being reached by the focus group, the moderator made extra effort to investigate whether the consensus was accurate or a matter of peer pressure. A small focus group size may also not represent the larger population (Krueger & Casey, 2000); the focus group size was directly related to the number of participants in the study. Therefore, a small focus group size is a limitation of this study.

**Ethical Considerations**

Prior to the start of the study a certificate of ethics approval was granted from the Behavioural Research Ethics Board at the University of Saskatchewan. Case study participants were then informed about the study as a group and their parents or guardians were contacted by telephone. Participants, parents and guardians were all informed that participation was voluntary and that there were no expectations for students to participate. All participants and parts/guardians were assured of total anonymity and confidentiality throughout and after the study. Volunteer participant anonymity, as well as their responses, was guaranteed through the use of pseudonyms. Pseudonyms have also been used for the name of the school and the school division in the write up of the research study. Participants could withdraw from the study at any point without a penalty, by contacting the researcher in person, over the phone, or in writing.

The participants were assured that all transcripts of questions, test results and focus group recordings would be safely stored in a locked cabinet during collection and analysis of the study. Upon completion of the research study, this data will be kept in a secure location by Dr. Dirk Morrison, Department of Curriculum Studies in the College
of Education at the University of Saskatchewan for a minimum of five years in accordance with University of Saskatchewan guidelines.

The results of this research study will be shared with the faculty of Curriculum Studies at the University of Saskatchewan. The results will be used to complete requirements for a Master of Education degree in Curriculum Studies at the University of Saskatchewan. The results of this research may be published and/or presented at a relevant conference. The participating school division will receive a final draft of the thesis manuscript. Copies of the manuscript will be kept in the Education Library, College of Education and the Department of Educational Curriculum Studies Office, College of Education.

There were no known risks associated with this study. All participants were made aware of public access to the finished project at the University of Saskatchewan’s Education Library.
Chapter IV

Findings

The purpose of this study was to determine the educational potential of the serious game *Building Homes of our Own™* as a teaching tool in a high-school construction class. Four methods of data collection were employed to address the research questions. Chapter Four presents the findings from the pre- and post-tests, critical thinking questions, learning environment observation sheets and the focus group session. This study consists of four research questions, each utilizing one of the above methods for data collection. Each question is listed below accompanied with the data collected.

*Research Question #1: Could the serious game “Building Homes of Our Own™” be used to successfully teach construction curriculum objectives?*

A test was developed containing 18 questions applicable to both the game *Building Homes of our Own™* and to Saskatchewan’s construction curriculum (see Appendix D). The test was administered both before and after the students played the game. The following line graph indicates the percentage increase or decrease of participant’s post-test scores. All participant scores have been collapsed to obtain an overall percentage increase/decrease for each question.
The above graph indicates that, on average, post-test scores were higher than pre-test scores. The game appears most successful in teaching curriculum objectives when the graph swings up such as in questions 1, 7, 9, 13 and 14. Generally, these five questions dealt with listing professionals in the planning process of building a house and the various types roofing and siding materials. In questions 6, 15, 16 and 17, although minimally, students achieved lower test scores on the post-test compared to the pre-test. This is indicated when the graph swings below 0% on the graph. These four questions dealt with the roles of the professionals in the planning process of building a house.

Figure 1: Increase/Decrease of post-test scores
The test format used to gather knowledge gained from gameplay was short answer and the value of each question varied from one point to six points. To determine the average increase in curricular knowledge it was necessary to include the value of each question. The following table presents the combined points available for each question, the combined scores earned by students, as well as the difference between pre-test and post-test scores for each question. A positive difference indicates knowledge gained while a negative difference indicates a knowledge drop. The table also presents the overall average increase in curricular knowledge according to post-test results.
Table 1

*Difference in pre-test vs post-test scores*

<table>
<thead>
<tr>
<th>Question #</th>
<th>Points Available</th>
<th>Pre-test Points Obtained</th>
<th>Post-test Points Obtained</th>
<th>Increase/Decrease in test scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>68</td>
<td>5 (7.4%)</td>
<td>51 (75%)</td>
<td>+46 (67.6%)</td>
</tr>
<tr>
<td>#2</td>
<td>34</td>
<td>12 (35.3%)</td>
<td>15 (44.1%)</td>
<td>+3 (8.8%)</td>
</tr>
<tr>
<td>#3</td>
<td>17</td>
<td>7 (41.2%)</td>
<td>8.5 (50%)</td>
<td>+1.5 (8.8%)</td>
</tr>
<tr>
<td>#4</td>
<td>17</td>
<td>4 (23.5%)</td>
<td>5.5 (32.4%)</td>
<td>+1.5 (8.9%)</td>
</tr>
<tr>
<td>#5</td>
<td>102</td>
<td>11 (10.8%)</td>
<td>15 (14.7%)</td>
<td>+4 (3.9%)</td>
</tr>
<tr>
<td>#6</td>
<td>34</td>
<td>12.5 (36.8%)</td>
<td>11.5 (33.8%)</td>
<td>-1 (-3%)</td>
</tr>
<tr>
<td>#7</td>
<td>51</td>
<td>1 (2%)</td>
<td>34 (67%)</td>
<td>+33 (65%)</td>
</tr>
<tr>
<td>#8</td>
<td>17</td>
<td>8 (47.1%)</td>
<td>9 (53%)</td>
<td>+1 (5.9%)</td>
</tr>
<tr>
<td>#9</td>
<td>34</td>
<td>0 (0%)</td>
<td>5 (14.7%)</td>
<td>+5 (14.7%)</td>
</tr>
<tr>
<td>#10</td>
<td>17</td>
<td>2 (11.8%)</td>
<td>3 (17.6%)</td>
<td>+1 (5.8%)</td>
</tr>
<tr>
<td>#11</td>
<td>68</td>
<td>34 (50%)</td>
<td>40.5 (60%)</td>
<td>+6.5 (10%)</td>
</tr>
<tr>
<td>#12</td>
<td>17</td>
<td>6 (35%)</td>
<td>8 (47.1%)</td>
<td>+2 (12.1%)</td>
</tr>
<tr>
<td>#13</td>
<td>51</td>
<td>28 (55%)</td>
<td>36 (71%)</td>
<td>+8 (16%)</td>
</tr>
<tr>
<td>#14</td>
<td>51</td>
<td>21 (41.2%)</td>
<td>45 (88.2%)</td>
<td>+24 (47%)</td>
</tr>
<tr>
<td>#15</td>
<td>34</td>
<td>1 (3%)</td>
<td>0 (0%)</td>
<td>-1 (-3%)</td>
</tr>
<tr>
<td>#16</td>
<td>34</td>
<td>9 (26.5%)</td>
<td>8 (23.5%)</td>
<td>-1 (-3%)</td>
</tr>
<tr>
<td>#17</td>
<td>17</td>
<td>5 (29.4%)</td>
<td>3.5 (20.6%)</td>
<td>-1.5 (-8.8%)</td>
</tr>
<tr>
<td>#18</td>
<td>51</td>
<td>17 (33.3%)</td>
<td>21 (41.2%)</td>
<td>+4 (7.9%)</td>
</tr>
</tbody>
</table>

**Total Points**

| (Avg. test %) | 714 | 183.5 (25.7%) | 319.5 (44.7%) | +136 (+19%) (Overall Average) |

45
Table 1 further clarifies the game’s ability to teach curriculum objectives: a higher positive increase in individual question scores indicates where the game was successful whereas a lower positive score or higher negative score indicates where the game was less or unsuccessful. As shown in Table 1, the average score for the pre-test was 25.7% and 44.7% for the post-test. This presents an increase of 19% in post-test results indicating that knowledge was gained from game play.

Research Question #2: What type of learning environment was created by using the serious game Building Homes of Our Own™ as a learning tool for high-school construction technologies?

An instrument to observe the learning environment was developed and utilized to determine the type of learning environment created by using a serious game as a learning tool for high-school construction technologies (see Appendix G). Categories of the learning environment observation instrument include: on task behavior, collaboration, competition, problem solving and engagement. During each game play session the observation sheets were filled out by both the researcher and his assistant.

The following table lists each game play session and categories of the learning environment observed. Each section was given a rating out of five and this rating is an average of the researcher and researcher’s assistant’s individual ratings.
Table 2

Summary of learning environment scores

<table>
<thead>
<tr>
<th>Game play</th>
<th>Area of observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session</td>
<td>On Task Behavior</td>
</tr>
<tr>
<td>#1</td>
<td>5 / 5</td>
</tr>
<tr>
<td>#2</td>
<td>4 / 5</td>
</tr>
<tr>
<td>#3</td>
<td>4.5 / 5</td>
</tr>
<tr>
<td>#4</td>
<td>4.5 / 5</td>
</tr>
<tr>
<td>#5</td>
<td>4.75 / 5</td>
</tr>
<tr>
<td>#6</td>
<td>5 / 5</td>
</tr>
<tr>
<td>#7</td>
<td>4.75 / 5</td>
</tr>
<tr>
<td>Overall</td>
<td>4.6 / 5</td>
</tr>
</tbody>
</table>

As can be seen from Table 2, students scored high in the first four areas of the learning environment instrument (on-task behaviour, collaboration, engagement, and problem solving) and relatively low in the area of competition scoring. The following section provides a summary of the written learning environment findings for each area observed, using data (observation notes) captured by the researcher and researcher’s assistant during game play. The complete transcript of observations has been provided in Appendix J. To ensure complete anonymity, students have been given a letter pseudonym in place of their names.
On-Task Behavior

Students averaged 4.6/5 for on-task behavior. As stated in Table 2, on-task behavior was at its lowest during session #2 (4/5) and was its highest during sessions #1 and #6 (5/5). According to the on-task behavior rubric, this meant that students showed high levels of on-task behavior with very little or no off-task behavior observed. Further observation noted that students remained focused and on-task throughout the gaming sessions. At the beginning of each session students quickly logged on and went to work. They listened, followed directions well and were eager to collaborate. On the rare occasion there was some distracting behaviour (e.g., in one instance a student pushed another student’s escape key). On another occasion a few students became frustrated with the game design. Interestingly, this did not bother them for long and they kept on working. The most severe off task behavior occurred during session five when a student decided not to take the game seriously and began making silly decisions within the game. This only lasted for about five minutes and then he began a new game with more effort. Overall students behaved very well during the game play sessions remaining focused and on task.

Collaboration

An average score of 4/5 for collaboration indicated that students showed high levels of collaboration with few unresolved disruptions. The majority of students openly shared information and resources throughout, and after, each game play session. According to Table 2 the amount of collaboration varied little between sessions, with the most collaboration noted on game play session #1 with a rating of 5/5 and the least on
game play sessions #2, #5 and #7 with a rating of 3.5/5. Observers noted that collaboration occurred only between neighbors during the first couple of sessions. Soon two collaborative groups formed in opposite corners of the room. On a few separate occasions some students who were experiencing greater success with the game actually got out of their seats to help out their classmates. At times only a few students would be collaborating and at other times the room full of students would suddenly break into discussion. For some of the sessions collaboration would start off slow and then build as the students became more involved in their game. For other sessions collaboration would start immediately and later fade. Discussions about the game would often continue into the hallway and back at the classroom after the gaming session was done. Overall, collaboration amongst students appeared to be both prolific and positive.

**Engagement**

Students scored relatively high on engagement with an average score of 4/5. According to the rubric, students demonstrated that they were engaged when they frequently asked questions and made suggestions. On occasion, when class was finished, they were reluctant to stop game play. Some student comments included “Check it out! A skate park!”, or, “What else do we got here?” and “This is fun!” Students remained engaged both when the room was quiet and when it was noisy. As mentioned, at times the learning environment was quiet as students were extremely focused, other times, classroom discussion developed when someone was successful or found something new in the game.
The motivation for engagement varied from the first session to the last. At first, students were engaged primarily because playing a serious game “for school” was a new and exciting learning experience. Later on, during the gaming sessions, students remained engaged as they attempted to succeed in the game. The level of engagement remained quite high from game sessions #1 through #4. However, there were a few instances later on where some students became frustrated and wanted to quit. During session five, for example, the researcher and his assistant found that particular students were getting discouraged as they were not experiencing enough success. After a quick diagnosis, a short lesson on credit rating (the content/knowledge gap) was delivered resulting in continued and high engagement for session five. It is important to note, however, that despite the intervention of this lesson, which did help some students experience success, many failed to “wrap” (i.e., complete) level one and did not move on to level two. This lack of success is reflected in the drop of engagement scores during sessions six (2.75/5) and seven (3.5/5). This was mostly due to the lack of success and constructive feedback experienced during these particular game sessions (likely a design flaw of the game).

**Problem Solving**

An average score of 4.1/5 was achieved for problem solving. During the first few game play sessions, technical questions were addressed to the researcher and his assistant while students’ strategy for game play was mostly through their own trial and error. As the sessions progressed students began to ask their neighbors more in-depth questions, which often led to further discussion. As early on as session two, one student, who was experiencing more success, got out of his chair to help a student across the room. It was
observed that this type of help and problem solving increased during the next few game sessions. Students soon experienced greater problems, with some failures, and they quickly realized that research within the game would be required to be more successful. Research within the game was accomplished by hiring virtual professionals, going to virtual town meetings or by going to the game’s virtual library. As students progressed into the more difficult parts of the game, more questions were asked. As more questions were discussed, more were solved. On the other hand, with more questions and problems, more students became frustrated when problems were more complex and took longer to solve. This would often lead to students asking the researcher or his assistant questions rather than taking the time to seek out answers on their own. As mentioned, during session five, a quick lesson on credit rating was given because this information was not available in the game. Overall, however, students solved problems very well and independently with only minor interventions by the researcher and his assistant.

Competition

Competition scored very low for all seven gaming sessions, averaging 1.2/5. The researcher and researcher’s assistant monitored competition amongst classmates and through the game Building Homes of Our Own™. Competition was initially scored based on the amount of competition observed and subsequently on whether it was deemed positive or negative according to the rubric. It was very rare to observe any competition during any of the game play sessions. During the first session one student received more money from the bank than another student. However, this sparked more curiosity and discussion than direct competition. At times some students would take note that others
were pulling ahead of them, but there was no noticeable competition for them to catch up. When one student did pass level one he may have sparked some competition but his success seemed rather to motivate others and proved to them that it was actually possible to pass level one. Overall, the researcher and researcher’s assistant observed very little to no competition during all seven game play sessions across all students. Given the very low incidence levels observed, it was, therefore, not possible to accurately label whether the overall effect of competition was positive or negative.

*Research Question #3:* Did the serious game *Building Homes of Our Own™*, applied to teaching high-school construction technologies, support a learning environment that facilitates high-order thinking?

Seven critical thinking questions (see Appendix F) were created to address this third research question. These questions were designed to assess what order on the spectrum of thinking, according to Bloom’s (1956) taxonomy, that the game facilitated.

The following table includes student scores achieved on the seven critical thinking questions administered in part three of this study. As mentioned in Chapter Three, each question was created in association with one level of Bloom’s Taxonomy and has been placed in sequential order accordingly. For example, Question #1 correlates with the knowledge level of *cognition*, Question #2 correlates with the *comprehension* level of cognition and so forth. Each cognitive level has been listed below the question number in the first column of the table. Scores to student responses are located in the rows to the right of the corresponding question.
<table>
<thead>
<tr>
<th>Question #</th>
<th>Student Scores (letter indicates student designation)</th>
<th>High Score</th>
<th>Avg. Score</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>#2 Comprehension</td>
<td>N 9/12 C 9/12 R 3/12 J 3/12</td>
<td>9/12</td>
<td>6/12</td>
<td>6/12</td>
</tr>
<tr>
<td>#3 Application</td>
<td>B 6/10 G 8/10 Q 10/10 H 6/10 E 1/10</td>
<td>10/10</td>
<td>6.2/10</td>
<td>6/10</td>
</tr>
<tr>
<td>#4 Analysis</td>
<td>Q 7/10 P 9/10 O 2/10 G 2/10 E 3/10</td>
<td>9/10</td>
<td>4.6/10</td>
<td>3/10</td>
</tr>
<tr>
<td>#5 Synthesis</td>
<td>R 4/10 L 8/10 D 2/10 M 2/10 I 6/9</td>
<td>8/10</td>
<td>4.4/10</td>
<td>4/10</td>
</tr>
<tr>
<td>#6 Evaluation</td>
<td>A 5/10 F 0/10 C 5/10 M 9/10</td>
<td>9/10</td>
<td>4.75/10</td>
<td>7/10</td>
</tr>
<tr>
<td>#7 Evaluation</td>
<td>I 7/10 D 2/10 K 4/10 B 8/10 L 9/10</td>
<td>9/10</td>
<td>6/10</td>
<td>7/10</td>
</tr>
</tbody>
</table>

As mentioned earlier, there were a total of seven critical thinking questions. Each student was responsible for answering two out of the seven questions; one question during session eleven and one question during session twelve. Due to the relationship between questions and the number of students available to answer them, questions #1, #3, #4, #5 and #6 were answered five times while questions #2 and #6 were answered four times. Students A, J and P were all absent for one out of the two days allotted for critical thinking questions.

There were two questions created to examine whether the game taught evaluation skills. This was done to place increased focus on the capability of the serious game.
Building Homes of Our Own™ to address the highest level of cognition according to Bloom’s taxonomy. Evaluations of student response have been summarized and can be found in Appendix K.

Research Question #4: What are these high-school students’ perceptions regarding the integration of the serious game Building Homes of Our Own™, and serious games generally, for learning construction technologies?

A focus group was assembled in the gaming lab on the last day of the study to address the fourth research question. Focus group questions are listed in Appendix H and a complete transcript of questions accompanied by student responses has been included in Appendix L. The following is a summary of student responses to focus group questions. Questions one through four listed below were created as “warm up” questions (i.e., to help student relax with the setting and format of the focus group). Student responses to the first four questions have been summarized collectively.

1. You’ve now finished playing the game Building Homes of Our Own™. How many of you played video games prior to this game?

2. What kind of games did you play?

3. Did you ever think that you were learning things from playing those games?

4. So what kinds of things were you learning from those games?

Prior to playing Building Homes of Our Own™, 75% of the students questioned played video games. Some of these games included Grand Theft Auto™, Mario Brothers™, Halo 3™, Pac Man™, and Guitar Hero™. Many students thought they
learned something from playing these games whether it was hand eye coordination or certain beats in a song.

Questions five through seventeen were designed to address topics important for addressing the fourth research question.

5. The game you played for the past month is considered a serious game. It was designed to help educate students on the process of planning, building and selling a house. Do you think the game accomplished what it was designed for? How did it succeed or fail?

Most of the students came to the consensus that the game Building Homes of Our Own™ did successfully teach how to plan, build and sell a house. Student J commented specifically on something that he learned, “I thought that it taught you that if there is a house by the freeway than you should put in sound proofing or if you are planning to sell it to the elderly that it should be a one story house”. One student commented that the game had some design issues. It was decided by the researcher to expand on the design issues later in the focus group when asking about the strengths and weaknesses of the game. This decision was made to keep the focus group from veering off track.

6. What did you enjoy the most about learning using a serious game?

Many students enjoyed learning using a serious game, commenting, “It was challenging and really made you think.” They also liked the lifelike aspects and the fact that it taught information that was relevant and usable. Student Q commented, “I liked how the people around the community would give statements on whether or not you should build there and why. I learned where to build a house and find important
information”. Many students enjoyed learning from the game but said that because they often failed in the game, they quickly became discouraged.

7. What did you dislike the most about learning using a serious game?

Students disliked the fact that the game did not always give them specific details as to why they failed and the lack of constructive feedback that commonly followed. Students also commented that the game lacked complexity when it came to planning and designing their homes, as compared to other drafting and design activities. One student commented, “There were also a lot of aspects where it didn’t give you enough freedom. For example, it didn’t give you enough freedom in free-handing when you design your house. You really had to work with what the game gave you. You could have made some really nice houses with a better user interface.” Finally, students could not ask the game specific questions. Information had to be sought out through exploration, problem solving and trial and error.

8. What do you feel were strengths about learning this way?

The students did agree that there were many strengths of using a serious game for learning. Student B commented, “It was like being taught straight up. You got to learn at your own pace. So if some students didn’t know what they were doing it didn’t hold you up.” Students also compared learning this way to hands on learning but without the real consequences when major mistakes were made. Student L enjoyed the variety of scenarios offered by the game allowing him to be creative in many different ways.

9. What do you think was a weakness about learning this way?

Although student participants enjoyed learning using a serious game they agreed that there were also some weaknesses. The first weakness mentioned was that they could
not query the software directly with questions, which forced them to solve problems on their own. Although this was seen as a weakness by some of the students, encouraging the development of problem-solving skills is important to critical thought processes and learning in general; therefore this perceived weakness by the students may actually be a perceived strength by educators. Student C commented, “You can learn things from this game but obviously if you actually go out and do this stuff hands-on you can learn a lot more. It’s limited in that you can only learn information that is available within the game.” His statement then sparked mention that when you play a game you are really just playing and not physically participating. This also made the game hard to take seriously because there were no real consequences. Student M mentioned that the game “doesn’t really teach you people skills. There’s cartoon people that you talk to but you don’t actually go into a bank and negotiate. It’s kind of fake that way.” When the students were asked if they would have played differently if this were an evaluated assignment, they commented that they already were playing their hardest and marks would not have changed anything.

10. Was this a positive or negative experience? Explain.

All but three students questioned said that this was a positive experience. They enjoyed learning something new with a different learning tool rather than the traditional pencil and paper. This experience was also positive because it sparked students’ interest and accomplished teaching the basics about planning, building and selling a house. Student J commented, “I thought it was positive because you did learn quite a bit from the game. Like where to build and why you had to build there.” Students also enjoyed having fun while they were learning, “it created a more fun way of learning which made
it easier to remember information” (Student J). It was negative for others because the
game often became repetitive, lacked important information and did not offer enough
successes.

11 & 12. **Would you agree that the learning environment of the gaming classroom was
different from a traditional classroom? How was it different? Can you explain the
learning environment of this class? What did you like or dislike about it compared to the
learning environments of other classes?**

The class agreed that this learning environment was different from a traditional
classroom environment. Students commented that they were able to participate in open
discussion with their peers without penalty. Students also enjoyed that the environment
did not feel like a learning environment with a teacher’s desk and chalkboard but instead
like a gaming room. Students liked that the gaming environment allowed them to take
control of their own learning. Student I commented, “It was kind of cool because you sort
of taught yourself kind of how it went. Like you would learn something and then for your
next house you’d be like oh I could do that again because I know that now. And so it’s
not just a teacher standing there saying read this book and this will tell you what to do or
listen to me and I’ll tell you what to do. You kind of figured it out for yourself. It made
you think a little more.” Students also found the environment more relaxing and enjoyed
learning at their own pace.

13. **When you had questions about succeeding in the game how did you attempt to answer
those question (i.e.,) research at home, ask a friend, researched within the game etc.)?**

When students did have questions they found information from their neighbors,
the game library and experts within the game. Some also asked parents for information
and one student compared their gaming experience to what he was directly experiencing, as his parents were building a new home and selling their old one. One student had a discussion with his mom about advertising the house, “I moved a lot and my mom always read the newspaper and looked at all the different houses. She was attracted by the wording of the advertisements and explained what made them stand out.”

14. Did anybody here talk to other people about the building game you were playing for this class? How did they respond?

Nine out of the eighteen students also talked to their friends and/or family about what they were doing in their construction class. They mentioned to them that they were enjoying this serious gaming experience. Student D commented, “A lot of girls that I talk to ask what I do in this class. There like “Ah that would be so hard”. I was being pretty bragadocious! I was like, it’s not that bad. We’re actually having a lot of fun. We’re just playing on the computers right now building houses and stuff. They were kind of jealous.”

15. We’ve now finished playing the game. Some of you reached the last level of the game and some of you were still trying to get past the first level. Even though some of you didn’t successfully complete level one, do you still feel that you learned a lot about the house building and selling process?

Although many of the students did not make it past level one in the game, most students did feel like they learned a lot of information about planning, building and selling a house. Most students concurred that the game design was not very motivating and contained feedback that did not provide them with a lot of useful information. This made many of them feel like a failure at times. Student J commented, “Success in the
game was judged only on selling the house. We should have been judged at the end of each game phase.”

16. At this point in the game is there anything that you would like to change about the game?

Recommended changes to the game made by the students included providing better constructive feedback when they were unsuccessful and making the game more up to date as compared to COTS games. They also recommended including more complexity and visual detail in the game. Student Q commented that the visuals in the game were “pretty low compared to the other games we played.” Student I wanted to be able to see inside his house, “There’s a computer game called The Sims™ and you can actually pick out the furniture, the color of the walls and everything.”

17. Would you be open to using serious games for learning in the future? Why or Why not?

All students commented that they would be open to using serious games for future learning. (Unfortunately, the time allotted for the session ran out before they were able to explain further why or why they were not open to using serious games for learning in the future.)

Summary

Chapter IV presented the data collected for this study. Through the use of pre- and post-tests, higher-order thinking questions, direct observation of the classroom environment, and a focus group, this case study was designed to determine the educational potential of the serious game Building Homes of our Own™ as a teaching
tool in a high-school construction class. Eighteen students that were enrolled in the construction portion of their Practical and Applied Arts course participated in the study. This study collected an abundance of data, using a wide array of data collection techniques. In Chapter V, an extended analysis and interpretation of this data is presented.
Chapter V
Analysis of Findings

Discussion of Analysis

This chapter analyzes the four research questions that form the basis of this study. Each question and the data gathered for each has been analyzed individually. The researcher has included comments and reflections of events that were of special significance. Conclusions drawn from this study help to answer the underlying focus of this study, namely, the potential for using serious games for teaching high-school construction technologies.

Analysis

Analysis of Research Question #1: Could the serious game Building Homes of Our Own™ be used to successfully teach construction technology curriculum objectives?

Serious games are designed to specifically adhere to course and/or curriculum objectives. Due to the fact that Building Homes of Our Own™ was primarily designed for the educational system of the United States, it was of primary concern that the program be transferable to the Canadian educational context, and, more specifically, the Saskatchewan curriculum. Prior to the start of this study, a critical analysis was completed of the game Building Homes of Our Own™. The analysis consisted of studying the teacher’s manual, partaking in the self guided tutorial, playing the game and cross referencing learning outcomes with Saskatchewan’s construction technologies curriculum objectives. Upon completion of the critical analysis, it was found that
Building Homes of Our Own™ was clearly applicable to Saskatchewan’s Housing curriculum. The housing curriculum contains 15 modules accompanied by introductory, intermediate and advanced levels. When considering the applicability of the game in accordance to the curriculum, it was considered as either stand alone or as a supplemental teaching tool. Although Building Homes of Our Own™ was created for a foreign market, the game and assignments or worksheets used in conjunction with the game, covered nine Saskatchewan Housing modules and 39 learning objectives within those modules.

With the initial analysis supporting the game’s ability to teach curriculum objectives, it was now important to verify this information with the implementation of the game. A Grade eleven class was chosen because the curriculum supported the instruction of the content within the game and this class had not received any prior teaching on this subject matter. A test was then developed with questions relating to both the curriculum and the game. The test was administered prior to students playing the game in order to set a knowledge criterion level. An identical post-test was administered after game play sessions were completed and scores were compared to identify knowledge gained by the students.

For this study, the game was implemented as a stand-alone teaching tool. Other than game play session five, there was no classroom instruction on the topics the game taught. During the fifth game play session a short lesson on credit rating was given to help encourage success within the game. The decision to use the game as a stand-alone teaching tool was made primarily to answer the first research question: Could the serious game Building Homes of Our Own™ be used to successfully teach construction technology curriculum objectives? The researcher was interested in knowing whether the
game *itself* could be used to teach construction curriculum objectives. Therefore, if supplement lessons were provided alongside of game play it would be very difficult to determine if knowledge gained was from supplement lessons or from game play.

The test results indicated that students had a 19% knowledge increase as measured by the post-test results. Student scores on the test were 25.7% prior to the start of game play and 44.7% after game play sessions ended. A first impression of these results was disappointing. Average final scores after game play sessions were quite low, averaging below the passing grade of 50%. Upon further analysis however, it was recognized that students played a total of seven gaming session which averaged 40 minutes of game play per session. This totals approximately four and a half hours of game play. In four and a half hours, students learned important information on planning, building and selling a house. They were exposed to a hands-on learning environment where they interacted with various virtual citizens and professionals involved with the building process. Students learned where and how to gather important information both within the game and from peers. During this time the students had a 19% gain in curricular knowledge with little to no guidance from an instructor. It is the opinion of the researcher that with additional guidance from an educator with the utilization of discussion, worksheets, assignments and tests, knowledge gained from serious game play could potentially increase. Further guidance also stresses the importance of an educator as part of this type of learning environment.

A more detailed examination of the pre/post-test results reveals areas where the game *Building Homes of Our Own™* was more and less successful in teaching curriculum objectives. Test results indicated that the game was more successful in
teaching curriculum objectives that were addressed in questions 1, 7, 9, 13 and 14 of the test. These questions dealt with listing professionals in the planning process of building a house, and the various types roofing and siding materials. The game was less successful in teaching curriculum objectives that were addressed in questions 6, 15, 16 and 17, which mostly dealt with the roles of the professionals in the planning process of building a house. With this information educators can utilize discussions, worksheets, assignments and additional lessons that encourage thought and reflection in these areas and provide added guidance when seeking this information out within the game.

According to the critical analysis completed prior to this study, the serious game *Building Homes of Our Own™* contained an abundance of information that was applicable to Saskatchewan’s housing curriculum. Students had many opportunities within the game for learning information on planning, building and selling a house. As a stand-alone learning tool, the game was moderately successful at teaching curriculum objectives. It is the opinion of the researcher that with further guidance from an instructor and the incorporation of discussions, assignments, worksheets and lessons either developed by the teacher or borrowed from the supplementary teaching guide, the game *Building Homes of Our Own™* could very successfully be used as a teaching tool for teaching Grade eleven construction technologies. Without the use of discussions, assignments, worksheets and lessons, students will still gain relevant curricular knowledge from game play; however, this information will be less structured and more inefficiently acquired by students.
Analysis of Research Question #2: What type of learning environment was created by using a serious game as a learning tool for high-school construction technologies?

Five categories relevant to descriptions of learning environments in this context were observed by the researcher and his assistant during this study to include: on task behavior, engagement, collaboration, problem solving, and competition. With theoretical support and numerous meetings with research supervisors, it was determined that these five categories would establish a good foundation upon which to base a learning environment observation in a serious gaming study.

As mentioned, learning environment observation sheets were completed by the researcher and his assistant for each gaming session. Observation sheets included a scoring rubric, space for a score to be given to each category and space providing sufficient space for observers to write notes on each observation within each category. Students scored high in the first four areas of the learning environment instrument averaging 4.6/5 for on task behavior, 4/5 for collaboration, 4/5 for engagement and 4.1/5 problem solving and relatively low in the area of competition scoring 1.2/5. The scoring for each category provides a general idea of type of learning environment created by the game, however much more detail is available in the notes provided by the observers. These notes have been interpreted and analyzed in the following section.

**On Task Behavior**

When a teacher imagines 18 students playing digital games in his/her classroom, he/she may imagine an environment that is disorderly and difficult to manage! That was
furthest from the case for this study. Very few rules were given to the students who partook in this study (see Appendix E). In fact, students were allowed to talk with one another about the game and help each other out. Perhaps it was possible that students could not believe that they were not only allowed but expected to play a digital game for school and did not want to mess up this opportunity. Or, maybe, they were intimidated by the idea of being part of a study. Further analysis and reflection, however, points to neither of these being the case. In fact students listened attentively, followed directions, and were eager to help one another. Only on the rare occasion was there some off task behavior and this usually occurred when there was some frustration due to poor game design. It is this researcher’s view that students averaged 4.6/5 for on task behavior primarily because students were engaged.

Engagement

Digital games are engaging by design. There is one major difference when comparing digital games for entertainment and digital games for education (i.e., serious games) however, and that is money. The entertainment industry creates digital games with multi-million dollar budgets whereas most serious game producers are working with much smaller budgets. For this reason alone, the quality of serious games will usually be somewhat less when compared to commercial off the shelf (COTS) games. It is therefore unrealistic to expect students to be engaged in serious games to the same extent that they are engaged to the latest version of Halo™.

Students nonetheless scored quite high when considering their level of engagement during the serious gaming sessions. With an average score of 4/5, students
were often reluctant to stop game play and comments such as “This is fun” and “Check it out” were common statements heard by the observers. During the first few gaming sessions, students were primarily engaged with the novel idea of playing a digital game for school. However, it was more important for the purposes of this study to observe the engagement that came later on in the sessions, namely, the fact that the game design itself was engaging. An engaging game design will capture and maintain game player’s attention whereas being engaged in something just because it is novel tends to fade quickly.

Although the game design engaged students for many hours, there were a number of game flaws that quickly disengaged them. Frustration quickly escalated as many students began to experience a lack of success. Only a handful of students were able to get past level one, which led to discouragement and concession among the majority of the students. At one point, it was decided that a lesson was required to boost engagement (At the beginning of game session five a short lesson on credit rating was taught). This helped with engagement for that particular gaming session but it soon dropped after that with sessions six and seven scoring 2.75/5 and 3.5/5. Engagement, therefore, started high and remained relatively high for the first five sessions and then decreased during the last two.

**Collaboration**

Digital game playing has traditionally been viewed as an activity engaged in by oneself with little communication with the outside world. Perhaps this was the case in the early days of Pac-Man™ or Mortal Combat™, however, today’s games are very
different. Games such as *Wii Sports™* are being created to involve multiple players participating at the same time, and, MMORPGs are capable of supporting and engaging hundreds or thousands of players simultaneously. In these cases, the design of the game makes collaboration somewhat inevitable. This, unfortunately, was not the case with *Building Homes of Our Own™*.

*Building Homes of Our Own™* was created as a single-player game, indicating only one person can play the game at a time. Although many games are created today to accommodate the single player, those same games more often than not have an option to include two or more players, either through accommodating multiple console controllers and/or interaction with online players. Although this lack of multiple-player capability appears to be a downfall of the game design, collaboration was still possible amongst the students because they were all playing the same game at the same time and within the same environment.

Collaboration scored an average of 4/5 for the gaming sessions with a high score of 5/5 and a low score of 3.5/5. Students enjoyed openly discussing and collaborating with their peers during gaming sessions. Collaboration occurred mostly between neighbors, however, in two instances collaborative groups formed. These groups were on opposite ends of the room and discussions within them were civil and well mannered. At times, students would also get up and help one another out. Collaboration would usually be sparked by a problem or student remark originating from game play. Once a discussion started, it then continued to grow to grab the attention of others in the vicinity. Then, as quickly as it started, it would end and students would go back to individually playing the game with their newly found knowledge gained through collaboration. This
was perhaps the most interesting to watch and only on the rare occasion did discussions stray off topic (when discussion did stray off topic, students were usually frustrated with the game and losing interest).

In a serious gaming environment the amount of collaboration is easily manipulated. Rules could be put in place to discourage collaboration or effort can be made to encourage it. With the use of group discussions, worksheets or assignments, for example, a more collaborative environment can easily be created. In this study, the researcher chose neither to set rules against collaboration nor encourage it through group work. This, as much as possible, allowed observation of collaboration that was established only by the game and not by the researcher.

Problem Solving

Considered by some to be the most complex of thinking and learning processes, is being able to solve problems. Prior to the start of the game, students were guided through the very basics of playing Building Homes of Our Own™. During the first gaming session students were informed that there was a sufficient amount of information within the game to help them be successful. One of their initial tasks was to locate this information for future reference. After this brief introduction, the majority of initial game play was primarily through trial and error. The method of trial and error was used because it most closely replicated how a student would normally start playing a digital game (Branston, 2006). Learning a game through trial and error also encouraged problem solving right from the start. Also, although students could ask the researcher and his
assistant technical questions during the gaming sessions, it was encouraged that any questions relating to game play be directed to peers or to the game itself.

During the first couple of sessions, students primarily played through trial and error. When some failed by playing this way they attempted to get gaming information from the researcher and his assistant. At this time the students were reminded that they could find all of the information that they needed in the game by going to the virtual library, attending virtual meetings and hiring virtual professionals. Although there were many breakthroughs when solving problems within the game, many students found it difficult to pass level one. At this time it was decided by the researcher that the answers to the problems that the students needed to solve were not available within the game and a short lesson was given. This was the only time that intervention needed to take place in order to help solve problems.

The researcher recognizes that encouraging students to use the game or peers to solve problems may have increased the score obtained for problem solving. Prior to the start of the study a decision was made to use the game Building Homes of Our Own™ as a stand-alone learning tool. This decision ensured that knowledge being gained was from game play and not lectures given by the researcher or his assistant. If students were given information to help them solve problems it would have affected the validity of the data being collected for the study. Although encouraging students to solve problems on their own may have increased the amount of problem solving, it was necessary to protect the validity of research questions #1 and #3. On the other hand, choosing not to help students solve problems would have only a small effect on this section of research question #2.
Overall, students solved problems very well and so it was partially due to the design of the game and the choice to implement the game as a stand-alone learning tool that students found it difficult to pass level one. Students problem solved very well throughout the gaming sessions earning an average score of 4.1/5. Problem solving was well supported by both the serious game *Building Homes of Our Own™* and the learning environment that it created.

**Competition**

The most surprising finding in the study was the observation of a lack of competition. Competition is a defining feature of digital games and discussed frequently within digital gaming literature (Alessi and Trollip, 2001). The researcher and his assistant watched for competition amongst players and competition within the game itself. It was the perception of the researcher that almost all games contained or would elicit some degree of competition. This was not the case with *Building Homes of Our Own™*. Competition scored very low averaging only 1.2/5 for all seven gaming sessions. The original intent of the researcher was to score competition and then observe whether it was positive or negative. With the average score for competition being so low this was not possible. Two common terms that did come up when discussing competition with the researcher's assistant however, were *challenge* and *collaboration*.

In this serious gaming environment, students were challenged mostly by the game and, to some degree, by their peers. The game challenged students to think things through and to make good decisions within the game to be successful. Peers challenged each other when they were the first to learn something new or to jump to another phase or
level. They further collaborated with one another to find success within the game. It appears that competition within this game was not of major concern to the designers. An average mark was given upon completion of a level, however no extra points were available during the game and points could not be built up and saved level by level. Therefore, in place of competition, the designers of this game focused their efforts on creating a game that was challenging and bred collaboration rather than competition.

This part of the study found that on task behavior, engagement, collaboration and problem solving were well supported by the learning environment created by the game Building Homes of Our Own™. Competition on the other hand, was not a major part of the game. Instead game developers focused their attention on creating a game that was challenging. Data collected concerning the learning environment created by Building Homes of Our Own™ provided the researcher with important information to help answer the underlying question in this study. This part of the study found that the learning environment created by the game Building Homes of Our Own™ was orderly, easy to manage, it was engaging and challenging for students and information being learned and problems being solved were done so in a collaborative and cooperative environment.

Analysis of Research Question #3: Did the serious game Building Homes of Our Own™, applied to teaching high-school construction technologies, support a learning environment that facilitates high order thinking?

Up until fairly recently, educational digital games did not have the support of modern computing technology. They were often simple, point-and-click games that frequently lacked in-depth stories, simulations and role play opportunities. In fact, most
digital games for education were not games at all but digital representations of assignments that lacked depth and features usually associated with games (Rice, 2007). Serious games, on the other hand, include all of the above characteristics; they are complex educational digital games that often involve in-depth stories, simulations and role play opportunities, considered as important characteristics necessary for accessing higher-order thinking skills (Gee, 2003).

The serious game chosen for this study, Building Homes of Our Own™, was one of the very few games designed specifically for teaching construction technologies. As mentioned earlier, a critical analysis of the game Building Homes of Our Own™ was completed by the researcher prior to beginning this study. The analysis consisted of playing the game, identifying and comparing game objectives to curricular objectives and scoring the game according to Rice’s (2007) rubric for assessing critical potential in digital games (see Appendix A). Rice’s cognitive potential rubric was the only known method available during the research which gave users a method to score the potential for digital games to access high-order thinking skills. The game Building Homes of Our Own™ scored 9.5/20 on the rubric. This indicated that the game was in the lower-range and there were fewer opportunities for higher-order thinking to take place in the game. Although there were fewer opportunities for exercising higher-order thinking skills, the game scored high in three key sections of the rubric that related specifically to higher-order thinking: 1) The game has complex puzzles requiring effort to solve, 2) The game requires gathering of information and synthesizing in order to complete or successfully engage elements in the game, and 3) The game simulates complex processes requiring adjustment of variables by users to obtain desired results or adjusting variable leads to
different results. With this in mind it was determined that this particular research question was still worth pursuing.

Seven questions were developed to assess the thinking skills that the game taught. Thinking skill categories were directly associated with Bloom’s Taxonomy (1956) and included knowledge, comprehension, application, analysis, synthesis and evaluation. An examination of student scores for critical thinking questions indicates that all seven questions obtained high scores that were 75% or above. A simple deduction then would be to declare that having at least one student who obtained a high score for each question indicates that the game has the potential to facilitate that thinking skill. It is important to recognize however, that some students will have better cognitive tools and skills previously developed to answer critical thinking questions. This would give them an advantage over other students that have not yet developed these skills. Upon the second review of student responses to critical thinking questions, some interesting findings were exposed: in some instances, students who did not do well on answering critical thinking questions were quite successful in the game. Some of these same students simply answered the question wrong or exerted very little effort when answering the question.

The teacher’s guide included with the game *Building Homes of Our Own™* mentions the importance of equipping students with critical thinking, reasoning abilities, sound decision making and problem-solving skills. All of these can be considered as high-order thinking skills according to Bloom's taxonomy (1956). The designers of *Building Homes of Our Own™* created the game with these objectives in mind. During game session observations the researcher noted many instances when students exercised critical thinking, reasoning abilities, sound decision making and problem solving skills.
The game encouraged students to make wise informed decisions within all three phases of the game. In the planning phase, virtual properties needed to be assessed and decisions made concerning their potential for development. Virtual budgets needed to be created in relation to the properties chosen. Information needed to be collected from virtual town meetings, the virtual library and virtual professionals. After important research was completed, students used their newly-gained knowledge to construct a virtual house. In the building phase, students considered important factors that would affect the design of their house. Some of these factors included considering how the neighborhood, their budget and local bylaws affected the design and construction of their house. For example, if their lot was close to a highway, they would have to make the decision to use various types of soundproofing. If they were building in neighborhood where there was a high population of seniors, they would need to consider building a single story rather than a multi-story house. In the selling phase of the game, students used creative writing skills to generate a well-written advertisement. Within the advertisement, a sale price had to be established using a mathematical formula. After offers were made, students chose a virtual buyer according to criteria set out by the game. In this case, students practiced synthesis skills as they assembled new information and evaluated whether it adhered to set criteria. It is possible, therefore, that students who earned low scores on critical thinking questions, and were successful in the game, may very likely have learned high levels of thinking through game play due to the very design of Building Homes of Our Own™.

The results for critical thinking questions showed that every cognitive level had at least one response which earned 75% or above. Although some students may have had
previously developed cognitive tools and skills to better answer critical thinking questions, a simple inference could be made that the game facilitated all critical thinking levels. For those that did not have these skills, answering critical thinking questions may not have been the most suitable method in analyzing whether they were learning these skills. Instead many of these students displayed these skills by being successful in the various levels of Building Homes of Our Own™ which was designed to facilitate high-orders of thinking. A conclusion can be made therefore, that the game Building Homes of Our Own™ has the potential to facilitate varying levels of critical thinking that includes the higher levels of Bloom’s taxonomy.

Analysis of Research Question #4: What are these high-school students’ perceptions regarding the integration of the serious game Building Homes of Our Own™, and serious games generally, for learning construction technologies?

On the last day of the study the students were asked to participate in a focus group to comment on their serious game-playing experience. The focus group was held in the gaming lab and all 18 students who partook in the study were present. The session lasted 50 minutes and everyone was encouraged to participate in the discussion.

Focus group questions concentrated on seven main areas to include: likes and dislikes about learning via a serious game, the perceived strengths and weaknesses of using a serious game as a learning tool, whether the experience was positive or negative, comparisons to a traditional learning environment, information learned from the game, suggested changes to the game or gaming environment, and whether students would be open to using serious games for learning in the future.
The moderator started the focus group session with four warm-up questions used to help create a relaxed atmosphere and to initiate discussion. Although these questions were not directly related to the research questions it was interesting to discover that 75% of students had played digital games prior to this gaming experience and it was believed that they were learning something while playing those games, whether it was hand eye coordination or learning certain beats in a song. Very little time was spent on introductory questions as they were meant solely to initiate discussion. The following analysis of findings for research question #4 has been arranged according to the overall strengths and weaknesses of the game design and learning environment.

**Strengths**

Upon further discussion it was apparent that, overall, students really enjoyed this serious gaming experience. Positive comments were presented for both the game design and the learning environment created by using serious gaming. Students liked the challenging design, variety of scenarios, the relevant and useful information and lifelike aspects of the game. The students also enjoyed learning at their own pace rather than the pace of their classmates. If students wanted to advance and gain extra knowledge, the opportunity was easily afforded through further game play. Students also compared learning via a serious game to hands-on learning but without the real consequences when mistakes were made. When asked if the lack of consequences affected how they played the game, students responded that they were already putting a maximum amount of effort and consequences or evaluation would not have mattered. There was also a classroom
consensus agreeing that the game accomplished what it was designed for, which was educating students on the process of planning, building and selling a house.

The learning environment created by serious gaming was also important to the students’ overall enjoyment of their serious gaming experience. With the absence of a teacher’s desk and chalkboard, one student expressed that the gaming lab felt more like a “mad gaming room” rather than a traditional classroom. The atmosphere was relaxing and learning became fun for many of the students. This was partly due to the rules set by the researcher which allowed for open discussion relating to game topics. It is important to note that the atmosphere created by serious gaming is dependent on how the gaming environment is set up by the instructor. This study utilized an environment where there was no need for a teacher’s desk or chalkboard. Research sessions started and ended in a regular classroom where attendance was taken and a whiteboard was available to aid in delivery of important information. Students then ventured down the hall to another room that was set up specifically to accommodate a serious gaming lab. In this serious gaming scenario, students enjoyed going to the “mad gaming room”. A different atmosphere may have been experienced if the gaming lab was part of a regular classroom and lessons were incorporated into game play.

Weaknesses

Although the majority of students agreed that this was a positive learning experience, they stated several dislikes and weaknesses of using Building Homes of Our Own™, and serious games in general, as a learning tool. Dislikes and weaknesses were often directly related to design flaws within the game, however they were also related to
the game environment itself. The primary game design flaw was the lack of feedback given after a task or mission was accomplished. A simple summary of recommendations or commendations placed after the completion of such a task or mission would have been an excellent opportunity for reinforcement of learning. Instead, students were often shocked when feedback was negative, and provided little or no information to help them play the game better. One comment made by the game stated that the student “Lacks experience and imagination, cares little what the neighbors think, and is often over budget. Willing to start at the bottom. Need a new dog house or shed? 33%.” This was after the student made a $13,000 profit from selling his house! As a result of unconstructive feedback, students did not gain important information and progressed slower than necessary through the game. Unconstructive feedback also led to failure and students quickly became frustrated and discouraged. Students also commented that the first level in the game was much too difficult. A better game design would encourage success early on and move on to the more difficult tasks in later levels, a model commonly used in the entertainment games to capture and maintain player’s attention. Three students in the class commented that the gaming experience was negative for them because the game often became repetitive, lacked important information and did not offer enough successes. It was stated that game complexity and visual detail was not comparable to games that students play at home. Suggestions were made that creating a 3D avatar and being able to walk around and be involved in a 3D virtual world would be very beneficial to the game design.

Additionally, students mentioned a number of weaknesses of the serious gaming learning environment. It was stated that human interaction and people skills are hard to
learn from a computer. Interestingly, students stated that they enjoyed interacting with their teachers in a traditional classroom, whether it was asking question or becoming involved in more in-depth discussion. Once again, it is important to note that increased human interaction with teachers is possible within a “hybrid” learning environment which integrates lessons and assignments with game play.

The underlying focus of this study was to explore the potential for using serious games for teaching high-school construction technologies. The analysis of data collected through a pre/post-test, critical thinking questions and observation of the learning environment provided information relating to the Saskatchewan curriculum and instructional theory. The fourth research question was designed to acknowledge student perceptions on the integration of the serious game Building Homes of Our Own™ (and serious games generally) for learning construction technologies. The analysis for research Question #4 was arranged into two sections to discuss the strengths and weaknesses and revolved around game design and the serious gaming learning environment. The number of strengths and weaknesses were similar, however according to the students, strengths outweighed the weaknesses and overall this was a positive learning experience for them. Three students commented that information learned from the game was sometimes repetitive and lacked important detail, however the majority thought the game was relevant, useful and generally taught the basics of planning, building and selling a home. Overall, students enjoyed this serious gaming experience and were open to using serious games for future learning.
Conclusion of Analysis

Four research questions were designed to gather data for this study:

1. Could the serious game Building Homes of Our Own™ be used to successfully teach construction curriculum objectives?

2. What type of learning environment was created by using the serious game Building Homes of Our Own™ as a learning tool for high-school construction technologies?

3. Did the serious game Building Homes of Our Own™ applied to teaching high-school construction technologies support a learning environment that promotes a high order of thinking?

4. What are these high-school student’s perceptions regarding the integration of the serious game Building Homes of Our Own™, and serious games generally, for learning construction technologies?

Analysis of the data collected for these four questions provided the researcher with sufficient evidence to answer the underlying question of this study: Is there potential for using serious games for teaching construction technologies?

Research question #1 concluded that the game Building Homes of Our Own™ contains a considerable amount of information that is applicable to Saskatchewan’s high-school construction curriculum. This was determined through the use of an identical pre-test and post-test which contained material applicable to both the serious game and the Saskatchewan curriculum. Students increased their test scores by 19% primarily by playing the game for seven 40 minute sessions. It is predicted by the researcher that with
guidance from an instructor and the incorporation of discussions, assignments, worksheets and lessons, knowledge gained would substantially increase.

Question #2 indicated that the learning environment created by the game was very conducive to learning. Students were very much engaged in the game, problems were solved and information was being learned both collaboratively and cooperatively. The learning environment was easily controllable and students were on task and well behaved. At no time did the researcher and researcher’s assistant struggle to manage the serious gaming learning environment.

Research question #3 found that the game Building Homes of Our Own™ not only taught information that was applicable to Saskatchewan’s curriculum but also used methods that facilitated varying levels of critical thinking. Seven questions were primarily used to analyze levels of critical thinking. Student responses to these questions supported that all levels, including the highest level of Bloom’s cognitive taxonomy were potentially facilitated by the game. Students’ further demonstrated higher-order thinking when they were successful in a game that was designed to facilitate critical thinking, reasoning abilities, sound decision making and problem-solving skills.

For research question #4 students responded to various focus group questions. These questions revolved around the strengths and weaknesses according to game design and the serious gaming learning environment. Although strengths and weaknesses were similar in number, the majority of students agreed that this was a positive learning experience and were open to this type of learning in the future.
Chapter VI
Recommendations and Conclusions

On a personal note

Prior to the start of this study I played and analyzed a variety of serious games to develop a better understanding of their design and characteristics. The games I played were applicable to various topics within Practical and Applied Arts (P.A.A.). During my analysis of these games I was intrigued by the amount of pertinent P.A.A. information available to players and questioned whether this type of learning tool was being considered by the education community. It was also discovered that many of the motivators that I discovered while playing these games were being talked about in the educational research literature concerning serious gaming. My interest in serious gaming led to numerous questions which I primarily directed towards my colleagues. Naturally, some of my colleagues questioned the utility of serious games for learning in an environment that is typically very hands-on. My response was that there is an abundant amount of theory that needs to be covered in teaching the construction curriculum and that this game was only meant to be included in the theory section rather than in the hands-on environment.

Prior to the start of this study I asked myself, “How can I make this study the most useful to educators? What would teachers need to know prior to implementing Building Homes of Our Own™ (and serious games generally) into their course?” Upon deeper consideration I came up with four research questions. These questions asked how well the game teaches curriculum objectives, how well the game facilitates critical
thinking skills, what kind of environment is created by serious gaming in teaching construction and what do students think about using serious games in the classroom? However, all four questions were designed to answer the singular guiding research question: what is the potential for serious games for teaching high-school construction technologies?

**Recommendations**

Serious game research has a relatively short history as compared to the long history of education. Still in its infancy, serious game research requires further exploration in many areas. Although research is still needed to expand our knowledge and understanding regarding the effectiveness of serious games, a reasonable proportion of past research has focused on this area. In this author’s opinion, future research needs to move past efficacy and into application. Serious games are being created for various areas and levels of education, however very few studies utilize in-depth research of specific games and their application to specific curriculums. Instructional strategies must also be examined and created for optimal implementation of serious games into the classroom. Also, further research should move past focusing only on core courses (e.g., math, science, social studies) and into optional courses such as design, hospitality and agriculture.

Serious games are defined as complex educational digital games that often involve in-depth stories, simulations and role-play opportunities. The characteristics of serious games place them in a position to facilitate critical thinking including the higher orders according to Bloom’s taxonomy (1956). With the potential to facilitate multiple
levels of critical thinking, further research is needed to advance serious games as useful learning tools which play a more integral part in the future of learning.

**Conclusion & Implications for Practice**

When considering a new learning tool in education, it is critical to first determine if the tool is right for the application, the context, and the learners. Once this question has been sufficiently addressed, the next question is “does the teaching tool capably and efficiently teach curriculum objectives?” This study found that the game *Building Homes of Our Own™* was successful in teaching construction objectives. However, this researcher speculates that with the integration of discussions, worksheets, assignments and lessons to help guide learning, such as those available in the teacher’s guide, educators could increase the efficiency, amount and focus of knowledge gained.

After the serious game has been linked with curriculum objectives the educator would be interested in knowing which levels of cognition that playing the game facilitated. With the use of critical thinking questions and direct observation, the researcher found that the game has the potential to facilitate all orders of Bloom’s taxonomy including knowledge, comprehension, application, analysis, synthesis and evaluation. As a stand-alone learning tool however, teaching higher-order thinking skills was not one of the game’s strengths. This is not to say that learning these skills is not possible from this game or serious games in general. The technology for creating complex games with features necessary to teach higher-order thinking skills is currently available. This technology is evident in many commercially available entertainment games, and increasingly in serious games. If educators of construction want to ensure
teaching higher-order thinking through the use of playing Building Homes of Our Own™, then it is recommended by this researcher that supplemental material such as discussion, worksheets, assignments and lessons be incorporated into the student's serious gaming experience.

Once the educator has determined if information within the game relates to the curriculum and the game has the capacity to teach a variety of cognitive skills, he or she would be interested in what type of environment to expect with the integration of a serious game. The researcher found in this study that the learning environment created by Building Homes of Our Own™ was very conducive to learning. Students were well behaved, on task, motivated, engaged and learning in a collaborative manner. The researcher and his assistant were very impressed with the game's apparent ability to capture and maintain student's attention while teaching them important information about planning, building and selling a house.

At the end of the gaming sessions the researcher had an opportunity to have students participate in a focus group. All students attended and were eager to share their thoughts and concerns about using the serious game Building that Homes of Our Own™ as a learning tool. Students made very noteworthy comments, many of which were comparable to remarks made by previous researchers. Students found a multitude of strengths and weaknesses with the game's design and with the environment it created for learning. The students agreed that the strengths outweighed the weaknesses and that this was a positive learning experience for them. They further commented that they would be open to using serious games for future learning.
With data obtained from this study the researcher came to the following conclusions. Serious games are a new and exciting method and technology that unlocks further opportunities for educating and learning. They have been proven to be excellent motivators, are capable of containing large amounts of information and have the ability to teach a variety of thinking skills. It is possible for educators to use serious games and maintain a structured and manageable classroom environment. Students enjoy learning with serious games and will look forward to this approach to learning in the future.

Although serious games are becoming increasingly available to educators, the industry is still in its infancy and steps are needed to ensure that these games are at least comparable in complexity and quality of game play with commercially available off the shelf games. The game Building Homes of Our Own™ has proven to have great potential for teaching construction technologies. To ensure that students learn important information that challenges a variety of cognitive skills and provides focus in specific areas, educators need to integrate a variety of additional teaching tools and opportunities (e.g., discussions, worksheets, assignments, supplemental lessons and tests, etc.) with serious game playing.
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Appendices

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Appendix A

**Rubric for Assessing Cognitive Potential in Video Games** (Rice, 2007)

(Includes scoring of the game *Building Homes of Our Own™*)

Upon evaluating a video gaming product, teachers should answer the yes/no indicators in the rubric with a 1 for yes and 0 for no. The higher a game scores on the index, the more opportunities the game will afford users higher order thinking, while the opposite is true for lower scores (Rice, 2007).

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Y/N 1/0</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requires users to assume a role in the game, rather than simply play.</td>
<td>N=0</td>
<td>Each game player has the same role and objective</td>
</tr>
<tr>
<td>Offers meaningful interaction such as dialogue with non-playing characters(NPCs)</td>
<td>N=0</td>
<td></td>
</tr>
<tr>
<td>Has a storyline.</td>
<td>Y=1</td>
<td></td>
</tr>
<tr>
<td>Has a complex storyline with characters users care about.</td>
<td>Y=.5</td>
<td>Storyline is basic and not malleable.</td>
</tr>
<tr>
<td>Offers simple puzzles.</td>
<td>Y=1</td>
<td>The game has many puzzles that make the player search out information.</td>
</tr>
<tr>
<td>Has complex puzzles requiring effort to solve.</td>
<td>Y=1</td>
<td></td>
</tr>
<tr>
<td>Uses three-dimensional graphics.</td>
<td>Y=1</td>
<td>Yes-Low quality</td>
</tr>
<tr>
<td>Allows multiple views or camera pans and the ability to zoom in and out.</td>
<td>Y=.25</td>
<td>Only X and Y-axis movement</td>
</tr>
<tr>
<td>Simulates complex processes requiring adjustment of variable by users to obtain desired results or adjusting variable leads to different results.</td>
<td>Y=1</td>
<td>There are some choices but these are limited.</td>
</tr>
<tr>
<td>Allows interaction through use of avatars.</td>
<td>N=0</td>
<td></td>
</tr>
<tr>
<td>Avatars are lifelike.</td>
<td>Y=.5</td>
<td>Some lifelike characteristics.</td>
</tr>
<tr>
<td>Requires interaction with virtual elements within the game</td>
<td>Y=.5</td>
<td>Some interaction.</td>
</tr>
<tr>
<td>Requires knowledge of game elements beyond mouse prompts, number entry (e.g., combining elements to create new tools, understanding complex jargon).</td>
<td>Y=1</td>
<td></td>
</tr>
<tr>
<td>Requires gathering of information and synthesizing in order to complete or successfully engage elements</td>
<td>Y=1</td>
<td></td>
</tr>
</tbody>
</table>
in the game.

<table>
<thead>
<tr>
<th>Environment effectively replicates real world</th>
<th>Y=.25</th>
<th>This could be improved upon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non player characters display artificial intelligence(AI) characteristics.</td>
<td>N=0</td>
<td></td>
</tr>
<tr>
<td>Non player characters display effective use of AI resulting in dynamic experiences for the user.</td>
<td>N=0</td>
<td></td>
</tr>
<tr>
<td>Offers replay ability with varying results</td>
<td>N=0</td>
<td></td>
</tr>
<tr>
<td>Total Score: (Indicating placement on the Video Game Cognitive Viability Index)</td>
<td>9.5</td>
<td></td>
</tr>
</tbody>
</table>

**Video Game Cognitive Viability Index**

<table>
<thead>
<tr>
<th>Score Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>Perfect score. Game displays highest elements of cognitive viability.</td>
</tr>
<tr>
<td>15-19</td>
<td>Upper-range. Game holds several positive characteristics lending itself to higher order thinking skills.</td>
</tr>
<tr>
<td>14-18</td>
<td>Mid-range. Game is probably acceptable for some higher order thinking opportunities.</td>
</tr>
<tr>
<td>9-13</td>
<td>Lower-range. Fewer opportunities for higher order thinking will take place in the game.</td>
</tr>
<tr>
<td>0-8</td>
<td>Little or no cognitive viability. Typical score range for arcade-style only games.</td>
</tr>
</tbody>
</table>
Appendix B

Research Schedule

There were three methods of data collection during the study. These included the administration of questions and tests, observation of the learning environment, and the utilization of a focus group. The schedule for the collection of this data is presented below.

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>September 3rd</td>
<td>Send in Application to the Behavioural Research Ethics Board for approval of research protocol</td>
</tr>
<tr>
<td>September 17th</td>
<td>Submit an official request to the school division and school principle for permission to conduct study</td>
</tr>
<tr>
<td>October 22nd</td>
<td>Session #1: Explanation of research project and distribution of assent/consent forms</td>
</tr>
<tr>
<td>November 6th</td>
<td>Session #2: Administer Pre-tests</td>
</tr>
<tr>
<td>November 8th</td>
<td>Session #3: First game play session – Explanation of the game and operating system</td>
</tr>
<tr>
<td>November 13th</td>
<td>Session #4: Game play session – Observe the learning environment</td>
</tr>
<tr>
<td>November 15th</td>
<td>Session #5: Game play session – Observe the learning environment</td>
</tr>
<tr>
<td>November 20th</td>
<td>Session #6: Game play session – Observe the learning environment</td>
</tr>
<tr>
<td>November 22nd</td>
<td>Session #7: Game play session – Observe the learning environment</td>
</tr>
<tr>
<td>November 27th</td>
<td>Session #8: Game play session – Observe the learning environment</td>
</tr>
<tr>
<td>November 29th</td>
<td>Session #9: Final game play session – Observe the learning environment</td>
</tr>
<tr>
<td>December 4th</td>
<td>Session #10: Administer post-tests</td>
</tr>
<tr>
<td>December 6th</td>
<td>Session #11: Administer critical thinking questions – Part 1</td>
</tr>
<tr>
<td>December 7th</td>
<td>Session #12: Administer critical thinking questions – Part 2</td>
</tr>
<tr>
<td>December 11th</td>
<td>Session #13: Assembly of focus group</td>
</tr>
</tbody>
</table>
Appendix C

Participant Information/Consent Form

You are invited to participate in a research project entitled *The Potential of Serious Games for Teaching High-School Construction Technologies: A Case Study*. Please read this form carefully, and feel free to ask questions you might have.

**Researcher:**

Jeff Kardynal  441-0232  
Masters of Education Student  
Department of Curriculum Studies  
College of Education  
University of Saskatchewan

**Purpose and Procedure:** My project is called *The Potential of Serious Games for Teaching High-School Construction Technologies: A Case Study*. The purpose of this study is to investigate the potential for the use of serious games in teaching construction theory. For this case study students will write a pre-test and post-test, play the serious game *Building Homes of Our Own™* and partake in a focus group.

**Potential Benefits:** Increasing student’s desire to learn is strived for by most educators. Serious games are motivators themselves. By studying the potential for serious games in education, educators will open up new options and techniques for teaching and motivating students.

**Potential Risks:** There are no known risks for participating in this study. Every effort will be made to protect the names of individuals, school, and the school division using pseudonyms in all cases. Personal interviews will be scheduled at a time and location suitable to you, the participant.

**Storage of Data:** During collection and analysis, the data generated from your participation in the study, namely audiocassette and transcripts, will be stored in a locked cabinet. Upon completion of the research study, this data will be kept in a secure location at the University of Saskatchewan for a minimum of five years by Dr. Dirk Morrison Department Curriculum Studies College of Education in accordance with University of Saskatchewan guidelines.

**Confidentiality:** For the interview participants, data will be gathered via a personal semi-structured audio-recorded interview. At any time the interviewee may request to have the recording device turned off. I anticipate that the interview will require approximately 60 minutes of your time. Direct quotations from the interview may be reported in the study. Pseudonyms will always be used to protect your identity. All identifying information...
will be removed from the data and will not appear in the completed project to maintain confidentiality.

**Right to Withdraw:** Your participation is voluntary, and you can answer only those questions that you are comfortable with. There is no guarantee that you will personally benefit from your involvement. The information that is shared will be held in strict confidence and discussed only with the research team. You may withdraw from the research project for any reason, at any time, without penalty of any sort without any loss of relevant entitlements. If you withdraw from the research project at any time, any data that you have contributed will be destroyed at your request.

**Questions:** If you have any questions concerning the research project, please feel free to ask at any point; you are also free to contact the researchers at the numbers provided if you have other questions. This research project has been approved on ethical grounds by the University of Saskatchewan Behavioural Research Ethics Board on September 13th, 2007. Any questions regarding your rights as a participant may be addressed to that committee through the Ethics Office (966-2084). Out of town participants may call collect.

**Follow-Up:** You will have public access to the completed study in the University of Saskatchewan library. You may also request verbal debriefing and feedback on you interview dialogue or review the final draft of the project by contacting me at the numbers listed above.

**Consent to Participate:**

(a) Written Consent

I have read and understood the description provided; I have had an opportunity to ask questions and my questions have been answered. I consent to participate in the research project, understanding that I may withdraw my consent at any time. A copy of this Consent Form has been given to me for my records.

___________________________________  ______________ _______________
(Name of Participant)       (Date)

___________________________________  ______________ ________________
(Signature of Participant)     (Signature of Researcher)
Appendix D

Pre-test/Post-test administered to test curricular knowledge gained

Research study of Grade 11 students enrolled in high-school construction courses

Housing 20 Pre-test/Post-test

The following test has been designed to better understand your background in the process of planning and building a house. The test does not count for any marks towards your final grade for this course. Please try your best and answer all questions to the best of your ability. Once you have finished please read over the test to make sure you have missed anything or made any unnecessary mistakes.

1. List 4 professional that are involved in the planning process of building a house. (4)

1. __________________________________________ 2. __________________________________________

3. __________________________________________ 4. __________________________________________

2. What is a building permit and why is it important to the housing industry? (2)

_________________________________________________ __________________________________________

_________________________________________________ __________________________________________

_________________________________________________ __________________________________________

3. Why may a soil scientist be helpful when planning to build a new house? (1)

_________________________________________________ __________________________________________

4. What are building codes? (1)

_________________________________________________ __________________________________________

5. Building codes include specific requirements for ____________________, ____________________, ____________________, ____________________, ____________________, and ____________________. (6)

_________________________________________________ __________________________________________
6. What is the role of the structural engineer in the house building process? (2) 
________________________________________________________________________
________________________________________________________________________

7. New houses are built upon a foundation. List three types of foundations. (3)
1. ______________________ 2. ______________________
3. ______________________

8. In order to keep house building costs on track a builder must prepare a(n) ___________ . (1)

9. What is the role of a civil engineer in the house building process? (2) ________________
________________________________________________________________________
________________________________________________________________________

10. What is the setback measurement when referring to lot planning? (1)
________________________________________________________________________
________________________________________________________________________

11. List 4 considerations when purchasing a lot on which to build a house? (4)
1. ______________________ 2. ______________________
3. ______________________ 4. ______________________

12. Why may it be important that an archaeologist is involved in the house building process? (1) ______________________
________________________________________________________________________
________________________________________________________________________

13. List 3 types of roofing materials. (3) 1. ______________________ ,
2. ___________________________ 3. ___________________________

14. List 3 types of siding materials. (3) 1. ___________________________ ,
    2. ___________________________ 3. ___________________________

15. A building envelope is the ___________________________ of a building. (2)

16. What is the role of an environmental consultant in the house building process? (2)
    ___________________________________________________________________
    ___________________________________________________________________

17. A professional who specializes in the design and aesthetics is called a(n) ____________, (1)

18. What are 3 good materials to use when considering soundproofing a new house? (3)
    1. ___________________________ 2. ___________________________
    3. ___________________________

You have reached the end of the test. Please read it over to ensure that you have answered every question to the best of your ability.

Score = __________ / 42
Appendix E

Computer Lab Rules

1. All equipment must be treated with the utmost respect.

2. There shall be no food or drinks in the computer lab.

3. Talking is allowed in the lab as long as it is not disruptive to other classmates.

4. Students may walk around the class and strategize with other classmates, however if discussions become off topic they will be asked to go back to their computer stations.

5. If questions arise from the game students are encouraged to respectfully ask other classmates or quietly raise their hand to ask one of the supervisors in the room.
Appendix F

Critical Thinking Questions administered in Part 3

1. List the three steps in building and selling a house. Explain in detail what is involved in each step. (Minimum half a page) /9

2. You have played a minimum of 2 out of the 4 game scenarios in Building Homes of Our Own. These scenarios included Urban, Suburban, Rivers and Lakes and Coastline. Choose 2 of the scenarios and compare them. When building a house in these two different scenarios what is similar and different about the two? List and explain 3 similarities and 3 differences. (Minimum half a page) /12

3. The following is an offering made to you by a prospective buyer. Using the bank’s criteria for credit approval listed below determine whether or not the bank will accept or reject this offer on your house. Explain why the bank accepted or rejected the offer. /12

Bank Criteria:

The bank will immediately turn down the loan application if:

- The bidders’ assets are less than the down payment.
  OR
- The bidders’ mortgage payment is more than 28% of monthly income.
  OR
- The bidders’ total monthly debt payment (mortgage plus “other”) is more than 36% of monthly income.
  ALSO
- The more stars a bidder has, the better chance of getting the loan approved

Credit Information:

| NAME: Thomas & Marlene Berry | RESIDENCE STABILITY: *** |
| OCCUPATION: Curator/English Professor | JOB STABILITY: **** |
| **OFFER: $192,000** | AVAILABLE CREDIT: **** |
| DOWN: 20% | PAYMENT HISTORY: *** |
| MORTGAGE PAYMENT: $1,127 | With 4 *s being the highest |
| ASSETS: $38,016 | |
| INCOME: $5,635 | |
| OTHER DEBT PAYMENTS: $1,071 | |
4. A buyer will come across varying prices when purchasing a lot on which to build a house. Why do lot prices differ and explain why a lot that sells for $90,000 may be a better bargain than one that sells for $45,000. /10

5. The bank has loaned you $285,000 to build a house. Using information learned in the game Building Homes of Our Own™ create a budget to build a house. Remember all of the “hidden” costs when planning a budget. /10

6. Is it relevant to seek advice from the community when considering where to build a house. List 4 reasons why it is or isn’t important to seek community advice. List and explain where else a builder may seek advice when planning, building and selling a house /13

7. Pick one level of the game and in no less than half a page, justify why the lot you chose to build on is better than the other lot choices. After you have completed writing, discuss your decision with someone who chose a different lot. After your discussion do you still agree that you picked the best lot? Why or Why not? /10
The purpose of this device is to help the researcher answer the second research question: **What type of learning environment was created by using a serious game as a learning tool for high-school construction technologies.**

**On Task Behavior**

This section will help determine whether or not the game is capturing and maintaining student attention. If students aren’t staying on task with the game and this learning activity this may be due to many factors. In the notes area of this section the observer will further describe why students appear to be or appear not to be staying on task.

<table>
<thead>
<tr>
<th>Very High (5)</th>
<th>Moderately High (4)</th>
<th>Average (3)</th>
<th>Moderately Low (2)</th>
<th>Very Low (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students are on task throughout the observation period. No instances of off task behavior are observed.</td>
<td>Students are showing fairly high levels of on task behavior for the majority of the observation period (at least 80% of the session.) Off task behavior is noted in two or less individuals.</td>
<td>Students are displaying average levels of on task behaviour during the observation period (between 60% and 80% of the session.) Frequency of off task behavior is between three and five (displayed by three or more individuals.)</td>
<td>Students display below average levels of on task behavior, between 40% and 60%. Frequency of off task behavior is between five and seven.</td>
<td>Students are displaying high levels of off task behavior which may include but are not limited to (drifting off or sleeping, loud arguing, loud speaking, horseplay, noise, noncompliance, complaining and these behaviors clearly interfere with the ongoing activity of the group. Students display less than 12 minutes of on task behavior. Instances of off task behavior exceed seven.</td>
</tr>
</tbody>
</table>

Notes: (Please further explain students’ behavior. Are students staying on task with this learning activity? Suggest why or why not? Are students misbehaving? Suggest why or why not?)

---

Score ____/5
Collaboration

This section will be used to help determine if the environment created by the game encourages students to help one another by sharing game information and resources so as to reach common goals or assist each other.

<table>
<thead>
<tr>
<th>Very High</th>
<th>Moderately High</th>
<th>Average</th>
<th>Moderately Low</th>
<th>Very Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>(5)</td>
<td>(4)</td>
<td>(3)</td>
<td>(2)</td>
<td>(1)</td>
</tr>
</tbody>
</table>

Collaboration occurs throughout the observation period. Students regularly provide praise and positive feedback to one another.

Students are showing fairly high levels collaboration for the majority of the observation period (at least 80% of the session.) Two or less unresolved disruptions, by different individuals regarding sharing of information and resources are observed.

Students are displaying typical levels of collaboration during the observation period (between 60% and 80% of the session.) Frequency of unresolved disputes over resources is between three and five (displayed by three or more individuals.)

Students display below average levels of collaboration within the setting, between 40% and 60% of the observation period. Frequency of resource related unresolved disputes is between five and seven.

Students show a low level of collaboration with each other and with adults. This is shown in lack of sharing of information and resources. The environment focuses on individuality rather than working together. There are frequent unresolved arguments/conflicts about information and resources.

Notes: (Please further indicate how students are collaborating. Be sure to distinguish between on task collaborative discussions and off task discussion which would fit more appropriately in the above section.)

___________________________________________________

___________________________________________________

___________________________________________________

___________________________________________________

___________________________________________________

___________________________________________________

___________________________________________________

Score _____/5
Competition

It is common for competition to develop within a gaming environment. This may occur between individuals and/or groups within that environment. It is natural that individual competition will occur prior to group competition. A competitive environment can either support or discourage learning depending on whether it is positive or negative. Note that this study will not look at competitive groups vs one on one competition but look at the level of ALL competition within this learning environment.

<table>
<thead>
<tr>
<th>Very High</th>
<th>Moderately High</th>
<th>Average</th>
<th>Moderately Low</th>
<th>Very Low</th>
<th>Negative Competition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Competition</td>
<td>➤</td>
<td>➤</td>
<td>➤</td>
<td>➤</td>
<td>➤</td>
</tr>
</tbody>
</table>

The class has evolved into a positive competitive gaming environment. Student learning is increased through one on one positive competition or by helping fellow competitive group members with game objectives to challenge other competitive groups in the class. This level of competition occurs for 80% - 100% of the observation period.

Students are showing fairly high levels of positive competition for the observation period. This level of competition is occurring for approximately 60% - 80% of the time.

Approximately half of the class has developed a competitive relationship with one another. Some students have teamed up to compete against other groups of students while others choose to compete individually. This level of competition is happening for approximately 40% - 60% of the time.

Students display below average levels of competition during the observation session. Approximately 20% to 40% of students are engaged in competition, however it is often negative where students are misleading other students to gain success.

Students or groups of students are negatively competing against one another for personal gain. Learning is taking place but at the cost of other student’s learning success.

Notes: (Use the space provided, comment on whether or not students have become competitive within this environment and whether it is positive or negative competition. In a positive competitive environment students will push each other to be successful in the learning activity, whereas in a negative competitive environment students will work against one another to suppress learning. Also note individuals and groups of students who are being competitive for each gaming session that you observe.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
Score _____/5
## Problem Solving and Critical Thinking

This section observes if the gaming environment encourages problem solving and critically thinking.

<table>
<thead>
<tr>
<th>Very High</th>
<th>Moderately High</th>
<th>Average</th>
<th>Moderately Low</th>
<th>Very Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>(5)</td>
<td>(4)</td>
<td>(3)</td>
<td>(2)</td>
<td>(1)</td>
</tr>
</tbody>
</table>

When obstacles arise, students attempt to solve the problem either by themselves or with the assistance of other students or adults. This is indicated by students exploring game help menus or open discussion of the problem with other classmates.

Students are showing fairly high levels of problem solving and critical thinking for the majority of the observation period. At least 80% of problems and questions are resolved in a satisfactory manner.

Students display below average levels of problem solving and critical thinking within the observation period. Between 40% and 60% of problems and questions that arise during the observation period are resolved in a satisfactory manner.

When obstacles arise, students show little ability to attempt to solve the problem either by themselves or with the assistance of other students or adults. Instead, frustration increases and/or the student start to withdraw from solving the problem. Less than 50% of problems are resolved in a satisfactory manner.

**Notes:** (Various problems, questions and challenges will arise during the game play period. Observe and record how students attempt to solve problems and their degree of success in this gaming environment.)

---

Score _____/5
## Engagement

<table>
<thead>
<tr>
<th>Very High</th>
<th>Moderately High</th>
<th>Average</th>
<th>Moderately Low</th>
<th>Very Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>(5)</td>
<td>(4)</td>
<td>(3)</td>
<td>(2)</td>
<td>(1)</td>
</tr>
<tr>
<td>Students appear to be engaged in gameplay. Students ask questions, make suggestions, and show reluctance to stop game play. This level of focus occurs for the entire observation period.</td>
<td>Students are showing fairly high levels of engagement for the observation period (at least 80% of the session.)</td>
<td>Students are displaying typical levels of engagement during the observation period (between 60% and 80% of the session.)</td>
<td>Students display below average levels of engagement during the observation session, between 40% and 60%. They are frequently bored and restless.</td>
<td>Students seem vacant, restless, bored and lethargic. The environment lacks a sense of focused energy and involvement. Students are easily distracted and pulled from game play.</td>
</tr>
</tbody>
</table>

Notes: (Are students engaged in this learning activity or have they become bored and easily distracted? Please use this space to comment on student engagement. Catalogue why students appear to be disengaged from game play. Does disengagement appear to be due to game quality or is it due to other distractions such as neighbors pulling them off task? Note that if students are talking with other students about game play they would still be considered to be engaged.)

Score _____/5
Appendix H

Focus Group Questions

1. You’ve now finished playing the game *Building Homes of Our Own*. How many of you played video games prior to this game?

2. What kind of games did you play?

3. Did you ever think that you were learning things from playing those games?

4. So what kinds of things were you learning from those games?

5. The game you played for the past month is considered a *serious game*. It was designed to help educate students on the process of planning, building and selling a house. Do you think the game accomplished what it was designed for? How did it succeed or fail?

6. What did you enjoy the most about learning using a serious game?

7. What did you dislike the most about learning using a serious game?

8. What do you feel were strengths about learning this way?

9. What do you think was a weakness about learning this way?

10. Was this a positive or negative experience? Explain.

11. Would you agree that the learning environment of the gaming classroom was different from a traditional classroom?

12. How was it different? Can you explain the learning atmosphere of this class? What did you like or dislike about it compared to the learning atmospheres of other classes?

13. When you had questions about succeeding in the game how did you attempt to answer those questions? I.e.) research at home, ask a friend, researched within the game etc.

14. Did anybody here talk to other people about the building game you were playing for Industrial Arts? How did they respond?

15. We’ve now finished playing the game. Some of you reached the last level of the game and some of you were still trying to get past the first level. Even though some of you didn’t successfully complete level one, do you still feel that you learned a lot about the house building and selling process?

16. At this point in the game is there anything that you would like to change about the game? I.e

17. Would you be open to using serious games for learning in the future? Why or why not?
Appendix I

Guidelines used in the development of critical thinking questions

Questions administered in part three of the study were constructed according to Bloom’s (1956) levels of cognitive skills. Each cognitive skill is listed below with a brief description.

<table>
<thead>
<tr>
<th>Cognitive Skill</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>Recall facts, terms, basic concepts and answers.</td>
</tr>
<tr>
<td>Comprehension</td>
<td>Demonstrate that they understood fact by organizing, comparing, translating, interpreting, giving descriptions, and stating main ideas.</td>
</tr>
<tr>
<td>Application</td>
<td>Apply acquired knowledge to new situations.</td>
</tr>
<tr>
<td>Analysis</td>
<td>Examine and break information into parts by identifying motives or causes.</td>
</tr>
<tr>
<td>Synthesis</td>
<td>Compile information together in a different way by combining elements in a new pattern or purposing alternative solutions.</td>
</tr>
<tr>
<td>Evaluation</td>
<td>Present and defend opinions by making judgments about information, validity of ideas or quality of work based on a set of criteria.</td>
</tr>
</tbody>
</table>

Each question was designed to address one level in Bloom’s taxonomy of the cognitive domain. The following is a list of each question and the level they were designed to address. Key words used to classify each question have been italicized. Questions and values following each question help explain how questions were evaluated. A summary of student responses to questions have been listed in Appendix G.

1. **List** the three steps in building and selling a house. Explain in detail what is involved in each step. (Minimum half a page) (Knowledge) (Were the steps listed with a sufficient explanation of each step?)
2. You have played a minimum of 2 out of the 4 game scenarios in Building Homes of Our Own. These scenarios included Urban, Suburban, Rivers and Lakes and Coastline. Choose 2 of the scenarios and compare them. When building a house in these two different scenarios what is similar and different about the two? List and explain 3 similarities and 3 differences. (Minimum half a page) (Comprehension) (Were comparisons made for the intent of building? Were sufficient similarities and differences made to support their answer?) /12

3. The following is an offering made to you by a prospective buyer. Using the banks criteria for credit approval listed below determine whether or not the bank will accept or reject this offer on your house. Explain why the bank accepted or rejected the offer. (Application) (Was the correct answer given with proper justification?) /10

4. A buyer will come across varying prices when purchasing a lot to build a house on. Why do lot prices differ and explain why a lot that sells for $90,000 may be a better bargain than one that sells for $45,000. (Analysis) (Did the student make a clear argument as to why lots differ and why a more expensive lot may actually be cheaper?) /10

5. The bank has loaned you $285,000 to build a house. Using information learned in the game “Building Homes of Our Own™” create a budget to build a house. Remember all of the “hidden” costs when planning a budget. (Synthesis) (Was a budget created that was logical and that allocated money to appropriate areas?) /10
6. Is it relevant to seek advice from the community when considering where to build a house? List 4 reasons why it is or isn’t important to seek community advice. List and explain where else a builder may seek advice when planning, building and selling a house. (Evaluation) (Did the student successfully defend his/her answer and provide information on seeking house building advice for builders?) /10

7. Pick one level of the game and in no less than half a page, justify why the lot you chose to build on is better than the other lot choices. After you have completed writing, discuss your decision with someone who chose a different lot. After your discussion do you still agree that you picked the best lot? Why or Why not? (Evaluation) (Was justification made according to key concepts and facts learned in the game and through discussion with classmates?) /10
Appendix J

Transcript of the Learning Environment Observations

On Task Behavior:

Game Play Session 1

- Students are listening and following directions well.
- Students appear to easily understand material which seems to support staying on task.
- No one is horsing around during today’s class!
- Overall students are excellent

Game Play Session 2

- Students are interacting well with no off-task behavior
- Overall a good environment. The room settles quickly and students are working great.
- Some issues with the game design caused a few students to get frustrated.

Game Play Session 3

- Students are focused and the classroom is very well behaved.
- Students are on task for the majority of the class.
- Although the room is warm today there are no complaints. Some are even wearing sweaters!
- It appears that they are interested which is promoting good behavior.

Game Play Session 4

- Students get to work quickly
- Some students have stated today that the game has some issues. This has caused frustration and a little off-task behavior.
- Student O pushed student J’s escape button today showing some of the first off-task behavior.

Game Play Session 5

- Students were challenged today to complete level one so that everyone could start level two tomorrow. This encouraged students to help others who have been struggling.
- Students log in and get to work quickly. The beginning of class is quiet.
- One student is not taking the game seriously anymore, making meaningless purchases and being silly. This continues only for about five minutes until he starts a new game with more effort.
- Overall students working well.

Game Play Session 6

- As usual students start quickly and get to work
- To date there has been very little off task behavior. With approximately 65% of the students unsuccessful in level one so far, it is hard to believe that more students aren’t losing interest and off task.

Game Play Session 7

- It was mentioned today that this will be the last game play session. Students started with a lot of focus to try and get past level one
- The room has a little off topic chit chat at the beginning
- After five minutes of play there is very little to no talking.
- For a few minutes there are two students talking about other things than the game

Collaboration

Game Play Session 1
- Students interact well with other students and teacher.
- One computer froze today. The student was asked to work with another student while the computer was repaired. There were no student issues with this event.
- In general students are working well together. Looking at each other screens with small discussions relating to the game, for example, “What did you get?, What’s your percentage?, I won’t sell for that?, How do I get out of here? and so forth.

Game Play Session 2
- At the beginning some students started talking with neighbors to find out information about the game. By the end of class the majority of the class was collaborating.
- One student patted another on the back congratulating his neighbor when his permit was approved.
- Students are working well together. Good interaction between students.

Game Play Session 3
- Although students are quite close to one another in this lab they rarely get out of their seat to collaborate. Praise and positive feedback is mostly between neighbors.
- Some collaborative comments today include, “Brick is sure expensive for siding”, “I’m putting in a big window. Yeah me too”
Collaboration seems to come in waves. At times the game initiates a question and discussion evolves from a couple of people to three or four surrounding neighbors. All of a sudden the whole group erupts in comments and suggestions.

There also appears to be one section of the room that is collaborating more than the rest.

Game Play Session 4

- Students warm up quickly to collaborating.
- Student collaboration is occurring sooner and growing faster within the room.
- There is also an increasing amount of discussion about the game after the sessions have ended. Students are talking in the hallways and back in the classroom as well.
- Student D helped student E by getting out of his chair to physically show him the correct procedure for planning a house.

Game Play Session 5

- There was very little collaboration for the first half of the class. Students were focused and working quite individually.
- Collaboration increased at the end of class when students started figuring out why they were or weren’t successful.
- Students are getting along well socially.
- One of the more successful students got out of his seat to help another student.

Game Play Session 6

- Students are talkative today. Quite a bit of chit chat going on.
- Collaboration occurred at the beginning of the session, slowed down in the middle and increased again at the end.
- A new collaborative group of three has formed across the room from the main group of students that had formed a group two sessions back.

Game Play Session 7
- Collaboration is occurring only through neighbors today and no further.
- Once again student N was successful. His success motivated others in the room and sparked a bit of collaboration between him and his classmates.
- Collaboration in general increased towards the end of class.
- Overall students worked well together.

Engagement

Game Play Session 1
- Students are following steps well.
- The room is quiet as students are engaged and working well.
- Close attention being paid to computer simulations.

Game Play Session 2
- Students are very engaged in this game. It appears to be a new and exciting learning experience.
- There are no students bored or disengaged at this time.
- One student did remark “I don’t want to play, I quit”. He did however continue in the game and remained on task throughout the session.
- Some student comments include: “Check it out a skate park!”, “What else do we got here?”, “This is fun.”.
- When asked to quit today there was some reluctance within the group. They wanted to keep on playing.

Game Play Session 3
- Students are quite engaged in the game today.
- One student commented, “I like playing the game better than drafting the actual blueprints”.
- One student failed three times to get a building permit. He started fresh, succeeded, and was very excited.
- A “Good Job/Congratulations” sign came up for one student. He proudly displayed this to me and his neighbors.
- As class time passes students becomes more and more engaged and at times are even loud as they discuss the game.
- Many students were talking about the game today as they left the session. Four students wouldn’t leave class with everyone else.

Game Play Session 4
- 95% of students are engaged in the game today.
- All students are working quite well. There appear to be very few frustrations or distractions.
- Student O is not taking the game seriously. He appears to have lost some interest in the game.
- Overall students are focused and eager to be successful in the game.

Game Play Session 5
Today was very interesting. Students are very engaged until they start failing. There has been very little success up to this point and intervention was required today to help students experience some success. A short lesson on credit rating had to be given today to keep students engaged in the game. If this wasn’t done it would have been quite probable that students would have just given up and called it quits!

Students appear to be losing interest not only when they fail but when there is no feedback to tell them why they may have failed. For example the bank rejected an offer to purchase and gave no indication why. The game simply stated that you should try again and better luck next time.

Game Play Session 6
- Even after last session’s lesson, in general, students are not very successful in this game. Some are getting frustrating and losing interest. Amazingly however most are still engaged and trying to get past level 1.
- At least one student is still engaged and asked if he could get this game off the internet.
- Back at the classroom after the end of the game session has ended students are still talking about the game but not as much as before.

Game Play Session 7
- It is the last game session today and most students still want to at least finish level one.
- At the beginning of the session students appear not to be discouraged and continue on.
- One student put in a lot of effort today trying to get past level one. When he went to sell his house the game commented “Lacks experience and imagination, cares little what the neighbors think, and is often over budget. Willing to start at the bottom. Need a new dog house or shed? 33%”. This was after the student made a $13,000 profit from selling his house!

- Knowing that this was the last session some students simply gave up near the end of the session and started distracting others in the room.

**Problem solving**

**Game Play Session 1**

- Questions posed and answered quickly by the computer.

- Although students are allowed to ask each other questions the majority are trying to solve questions on their own or with the help of the computer.

- Some general technical questions being addressed towards the researcher.

**Game Play Session 2**

- Most problems are being solved individually or through peer interaction. Some students have attempted to come to me or to my assistant rather than trying and figuring out a solution on their own.

- Mid-way through class one student actually got up and started helping another student out.

- Some students are having to go backwards in the game to figure things out.

**Game Play Session 3**

- Students are collaborating to solve problems
- The first student was unsuccessful today. He was disappointed but relatively eager
to give it a second try.

- A second student *busted* his budget. This made people around him more cautious
of their spending.

- There was some strategy talk today such as “Let’s pick the cheapest amenities so
we don’t get “busted””.

- Many questions being asked today. Most to other students but some directed to
the researcher and researcher’s assistant.

**Game Play Session 4**

- As students progress into the more difficult parts of the game more questions are
being asked. As more questions are being discussed more are being solved. On
the other hand with more questions and problems more students are becoming
frustrated when problems take longer to solve.

- More students are reading offers and taking the time to calculate the right one to
accept.

- Students are putting a lot of effort into solving problems especially selling
strategies.

**Game Play Session 5**

- Questions are going around today regarding why buyers are being rejected by the
bank.

- Many students are seeking out answers from other students when they cannot find
answers within the game.
The last ten minutes of class there was a lot of problem solving. One student found a calculator which really helped people figure out and analyze credit reports.

Game Play Session 6

- As students are getting more frustrated they want to ask my research assistant or myself rather than their peers.
- Students keep pressing forward but as students fail and become discouraged they are tending to play recklessly.

Game Play Session 7

- “Oh I get it” was a statement made by one student after doing a lot of research in the virtual library to solve his problems.
- Half way through class and some frustrations starting to occur.
- Some strategy talk about smart saving.
- When students first started playing the game their strategy depended more on trial and error. After my brief lesson during session five more students have realized that they need to do research to be more successful in the game.
- Some students are still not taking the time to do calculations.

**Competition**

Game Play Session 1

- The game appears to give different amounts of money to different players. This has sparked some minor competition but mostly curiosity between two players.
- One student has pulled ahead of the others which has pushed some players to take note.
- No other competition noted during this session

Game Play Session 2

- Competition is quite low in today’s session. Only notable competitive statement was “My lot’s better than yours!”
- At this point students appear to be simply learning the game and competition isn’t a priority.

Game Play Session 3

- Competition isn’t too evident at this time. This may be partly due to the stage of the game where the students are at or this game may not lend itself well to competition.
- One student passed the first level today. He pumped everyone up and may have perhaps sparked some competition.
- No competitive remarks today.

Game Play Session 4

- Only one competitive remark in today’s session, “My house is better than yours”. There was no follow up comment or challenge. Just a quick remark and it was left at that.
- Anything at all that may possibly resemble competition is very minimal. Some discussion today around money, houses, who’s going to do what, etc. To assume that this is competition would really be grasping at straws!

Game Play Session 5

- No competition to report in today’s session.

Game Play Session 6
- The very minimal competition that there was during the first few session has pretty much been totally extinguished.

Game Play Session 7

- Student N did spark some competition as he was the only one to move to the last level. This only lasted for a short time as students continued on with their own personal goals.

- No other competition observed.
Appendix K

Summary of student responses to critical thinking questions

The following is a list of the seven critical thinking questions administered in part three of this study. A summary of student responses to questions have been provided below each questions.

1. *List* the three steps in building and selling a house. Explain in detail what is involved in each step. (Minimum half a page) (Knowledge) (Were the steps listed with a sufficient explanation of each step?) /9

Student O:

Student O listed numerous steps to building and selling a house. They weren’t placed under the three main sections taught by the game but they were listed in chronological order. Student O needed more detail in the house building phase of his explanation. He received a 6/9 for his answer.

Student N:

Student N supplied all the required information; however he did not place the information into the correct headings. For his answer he received an 8/9.

Student F:

Student F correctly identified the three steps in building and selling a house. He provided a short explanation of each step but left out important details. He received a 6/9 for his answer.

Student K:
Student K provided the correct steps to building and selling a house. His explanations of each step were a little vague and some information was placed in the incorrect steps. He received a 7/9.

Student H

This student only listed and explained one out of the three building and selling steps. He titled that step incorrectly but supplied quite a bit of relevant information. He received a 2/9 for his answer.

2. You have played a minimum of 2 out of the 4 game scenarios in *Building Homes of Our Own*. These scenarios included Urban, Suburban, Rivers and Lakes and Coastline. Choose 2 of the scenarios and compare them. When building a house in these two different scenarios what is similar and different about the two? List and explain 3 similarities and 3 differences. (Minimum half a page) (Comprehension) (Were comparisons made for the intent of building? Were sufficient similarities and differences made to support their answer?) /12

Student N:

Student N started by providing a brief summary of the lots available in both the urban and suburban scenario. He then made six applicable comparisons that a builder may be interested in. These included the difference in cost of preparing the building site, water and sewer systems, lot prices, parking, length of drive versus driveway and grants available for builders. He concluded by noting that building costs after the six differences were about the same. He received a 9/12 for his comparison.

Student C:
This student compared urban to suburban. His first comparison was the varying amount of site preparation required such as water, sewer and power. He then noted that you needed a civil engineer in a suburban setting to tell you what the lots needs. It was also noted that the lots are much bigger in the suburban setting compared to the urban although their price is similar. A very interesting comparison that he found when he went to sell his home is that more families appear to be purchasing houses in a suburban area compared to an urban environment. In this case, he commented, a builder would have to build a larger home for the suburban family rather than a smaller more pricey home in an urban setting. He received a 9/12 for his comparison.

Student R:

Student R focused mostly on the positives and negatives of living in either of the two settings. He did make a few comparisons that would be applicable for builders. These included the possibility of extra preparation required in the urban scenario due to older structures and that the amount of codes differ and bigger house sizes are possible in the suburban scenario. He received a 3/12 for these comparisons.

Student J:

Comparisons were made by this student that included the speed of development, the number of bylaws required to follow as well as the lot sizes. This student received a 3/12 for his answer.

3. The following is an offering made to you by a prospective buyer. Using the bank’s criteria for credit approval listed below determine whether or not the bank will accept or
reject this offer on your house. Explain why the bank accepted or rejected the offer.

(Application) (Was the correct answer given with proper justification?) /10

Student B:

Student B correctly determined that the bank would reject the bidder’s offer. He explained that the bidder’s total monthly debt payment is more than 36% of monthly income and that their assets are less than their down payment. His calculations for mortgage payment was incorrect. He received 6/10 for his answer.

Student G:

This student correctly calculated that the bank would reject the bidder’s offer because the bidder’s assets are less than the down payment and that the bidder’s total monthly debt payment is more than 36% of monthly income. He also calculated that the bidder’s mortgage payment is less than 28% of monthly income. He did not mention the bidder’s rating on residence stability, job stability, available credit and payment history. He received 8/10 for his answer.

Student Q:

Student Q provided a written explanation to why the bank would reject the bidder’s offer. The numbers to support his answer were listed on the question page. He received 10/10 for his answer.

Student H:

Student H correctly answered that the bank would reject the bidder’s offer. He provided one calculation and made further reference to the bidder’s payment history. He received 6/10 for his answer.

Student E:
Student E’s one sentence statement was correct however missing an explanation. He received 1/10 for his answer.

4. A buyer will come across varying prices when purchasing a lot to build a house on. Why do lot prices differ and explain why a lot that sells for $90,000 may be a better bargain than one that sells for $45,000. (Analysis) (Did the student make a clear argument as to why lots differ and why a more expensive lot may actually be cheaper?) /10

Student Q:

Student Q provided five good reasons followed up with explanations why lot prices may differ. In his answer he didn’t tie his information together to conclude why a more expensive lot may actually be a better bargain than a cheaper lot. His answer earned him a 7/10

Student P:

Student P provided 4 reasons and explanations on why lot prices may different. He concluded by explaining how a more expensive lot may be a better bargain than a cheaper one. He received a 9/10 for his answer.

Student E:

Two reasons why lot prices differ were given by student E. He also provided a short answer as to why a more expensive lot may be a better bargain than a less expensive one. His answer was overall very vague and lacked quite a bit of information. He received 3/10 for his answer.

Student O:
Student O misread the question. He listed two reasons why lot and house prices differ and then stated why a cheaper house may turn out to be more expensive in the long run. His answer was also vague and lacked information. He received 2/10 for his answer.

Student G:

Student G provided a very short answer that lacked specific information. His answer did not clearly state reasons for varying lot prices and required the evaluator to try and read into what he was trying to say. He received a 2/10.

5. The bank has loaned you $285,000 to build a house. *Using information learned* in the game *Building Homes of Our Own™ create* a budget to build a house. Remember all of the “hidden” costs when planning a budget. (Synthesis) (Was a budget created that was logical and that allocated money to appropriate areas?) /10

Student R:

Student R listed the five areas considered when planning a house building budget. He proceeded to make estimations within these five areas. Unfortunately his estimations were very vague. One example is when he estimated $75,000 to build rooms and buy flooring. His budget for his house building would not be sufficient enough to begin the building process. He received a 4/10 for his budget.

Student M:

Student M did not complete his question. He received a 2/9 for the work that he did complete.

Student L:
Student L provided a full page and a half write up of the budget creation process. He noted the steps that needed to be taken and what order they should be taken in. Regular construction costs along with hidden costs were mentioned in detail. The only downfall to his budget was that it wasn’t broken down into the five areas suggested by the game. Instead it was in paragraph form making it very difficult to breakdown and understand. His budget earned him an 8/10

Student D:

Student D took the time to write down the five areas for creating a budget. He filled out the first area and left the rest incomplete. For his budget he received a 2/10.

Student I:

Student I listed an abundant amount of information essential in his budget. This information was random and not listed in any type of order or format as required by the game. He received a 6/9.

6. Is it relevant to seek advice from the community when considering where to build a house? List 4 reasons why it is or isn’t important to seek community advice. List and explain where else a builder may seek advice when planning, building and selling a house. (Evaluation) (Did the student successfully defend his/her answer and provide information on seeking house building advice for builders?) /10

Student A:

Student A listed two reasons and one coinciding explanation for seeking community advice. He also listed two areas where additional information could be found including the government and an environmentalist. He received 5/10 for his answer.
Student F:

This student handed in a blank piece of paper. He received 0/10

Student C:

Student C mentioned that it is relevant to seek community advice because they will tell you about the neighborhood and issues such as sound and lot history. He also mentioned it would be important to get extra advice from professionals and city hall. He received 5/10 for his answer.

Student M:

This student provided three valid reasons why it is important to seek community advice. He then concluded by listing seven different professionals that a builder could hire when planning, building and/or selling a house. For his answer he received a 9/10

7. Pick one level of the game and in no less than half a page, justify why the lot you chose to build on is better than the other lot choices. After you have completed writing, discuss your decision with someone who chose a different lot. After your discussion do you still agree that you picked the best lot? Why or Why not? (Evaluation) (Was justification made according to key concepts and facts learned in the game and through discussion with classmates?) /10

Student I:

Student I mentioned the positives and negatives of the three lots in the urban game scenario. He then chose the largest lot because it had the most potential to develop into a nicely landscaped yard. He realized the lot was expensive but mentioned that the builder
could make it work if he really watched his budget. He also cautioned the builder against some precautions to take when building on this lot like nearby river and soil conditions.

This student did forget to mention information about the required cost of protecting the nearby river during house construction. This would be done through a filtration fence, conventional storm water system or bioretention system. He received a 7/10 for his answer.

Student D:

This student took a very logical approach to answering this question. First he wrote down all the information about the lot he chose. This included the lot number, location, zoning, information on sewer and water, parking and any special consideration for builder. Unfortunately after this he did not use any of these facts in his justification. The student did mention the fact that another lot had a water flow problem, however most of his justification was based on feeling rather than facts. He received a 2/10 for his answer.

Student K:

Student K chose lot 121 because is was the cheapest and it was simple to get a building permit. He mentioned that on another lot you had to hook up to city water which is quite expensive and another lot was located on a 100 year flood plain. His justification lacked information on the added costs of building on this property. He received 4/10 for his justification.

Student B:

This student justified his answer quite well. First of all he chose this lot because
it best matched the loan he was offered. He considered the neighborhood and its proximity to route 3 and an orchard where work may be found. Student B noted the cost of preparing the other properties for construction compared to this one. He also mentioned the environmental benefit of purchasing this lot. He received an 8/10 for his answer.

Student L:

After briefly describing his lot choice, this student wrote three good arguments on why he chose this lot. The first was based on the location. The second was based on utility savings and the third was that there was no soil, environmental or structural considerations for the builder to worry about. He also mentioned that the complications of the larger lot that his partner chose outweighed its nicer scenery. This argument was very well justified and he received a 9/10.
Appendix L

Transcript of student responses to focus group questions

1. You’ve now finished playing the game *Building Homes of Our Own*. How many of you played video games prior to this game?
   
   Thirteen students raised their hand. 12/16 = 75%

2. What kind of games did you play?
   
   Grand Theft Auto, Mario Brothers, Halo 3, Pac Man, Guitar Hero

3. Did you ever think that you were learning things from playing those games?
   
   Many students quickly responded “yes”, “Oh Yeah”.

4. So what kind of things were you learning from those games?
   
   How to navigate maps, hand eye coordination, certain beats in a song I guess.

5. The game you played for the past month is considered a *serious game*. It was designed to help educate students on the process of planning, building and selling a house. Do you think the game accomplished what it was designed for?
   
   How did it succeed or fail?

Student O: No it had some design issues. For example when people were giving you offers to purchase it didn’t always make sense that they were denied by the bank. It didn’t seem like it was real estate.

Researcher: Did you think it taught you anything?

   Student O: Yeah maybe some planning.

   Student J: I thought that it taught you that if there is a house by the freeway than you should put in sound proofing or if you are planning to sell it to the elderly that it should be a one story house.
Student I:  I think it succeeded in most points

6. What did you enjoy the most about learning using a serious game?

Student O:  I felt it was hard to succeed in the game which made it more of a challenge.

Student H:  It makes you think a lot harder than regular games.

Student J:  It kind of made you feel like it was real life.

Student G:  I like the way that it taught me something that I can use.

Student Q:  I liked how the people around the community would give statements on whether or not you should build there and why for reasons. I learned where to build a house and find important information.

Many students answered that the game was enjoyable until you failed.

7. What did you dislike the most about learning using a serious game?

Student J:  The game didn’t really tell you why you failed. You even made a thirty thousand dollar profit and then it would say you didn’t get enough.

Student P:  And then they would cut you down that you failed and called you names!

Student L:  There were also a lot of aspects where it didn’t give you enough freedom. For example it didn’t give you enough freedom in free-handing when you design your house. You really had to work with what the game gave you. You could have made some really nice houses with a better user interface.

Student J:  Yeah you really didn’t have to plan the house. You just showed where the rooms needed to go and the game did the rest.

Student L:  You didn’t have to hook up electrical or plumbing.

Student C:  I thought we would have only been able to do one or two houses in the time we had but many of us did a lot more. It was more quantity over quality.
Student I: There would be certain questions that the game couldn’t answer. Yeah if you were confused about something it just didn’t fit together. Somehow it just didn’t work and ended up frustrating people. It’s not like in a classroom where there’s more discussion involved.

8. What do you feel were strengths about learning this way?

Student B: It was like being taught straight up. You got to learn at your own pace. So if some students didn’t know what they were doing it didn’t hold you up.

Student F: It was really close to hands on like in a shop setting.

Student N: It was fun. I knew what I needed to do and built on that to move to the next level.

Student P: If you messed up it really didn’t matter you could just start over and try a different way. You didn’t really lose any money, just fake money.

Student L: You could make your house in a wide variety of places which could spark a lot of personal interest. You could then be really creative with what kind of house you wanted to build. Even if you didn’t have a large budget you could really do what you wanted in one area and make the budget work out in another area.

9. What do you think was a weakness about learning this way?

Student E: You couldn’t ask the computer direct questions. If you didn’t know why something wasn’t working you kind of had to figure it out on your own.

Student C: You can learn things from this game but obviously if you actually go out and do this stuff hands on you can learn a lot more. It’s limited in that you can only learn information that is available within the game.

Student G: You can’t physically do whatever you’re doing. You’re just kind of playing...
around in a simulation.

Student M: It doesn’t really teach you people skills. There’s cartoon people that you talk
to but you don’t actually go into a bank and negotiate. It’s kind of fake that way.

Student C: Its harder to take serious because there aren’t any real consequences for
failure.

Researcher: So if playing this game was for marks would it have changed your game
playing experiences?

Student K: I played my hardest. I don’t think marks would have changed the way I
played.

Researcher: Would marks have changed the way any of you played the game? Nobody
replied that marks would have made any difference in the way that they played
the game.

10. Was this a positive or negative experience? Explain.

Student J: I thought it was positive because you did learn quite a bit from the game. Like
where to build and why you had to build there. I don’t know I thought it was
pretty good.

Student O: Kind of negative because now I don’t think I’ll ever be able to sell a house.
Yeah kind of negative.

Student P: I say positive because it was a better experience than learning from paper and
pencil. You got to do something new. Learn with a different learning tool.

Student L: I’ll say positive because it sparked my interest and I enjoyed what I was
doing.

Student I: It was kind of both for me. The negative was like if I couldn’t sell the house or
if I went bust then you would just have to start over again. It was kind of repetitive. But it was really positive because it wasn’t just the same thing in the class. You didn’t just sit in the class and pretty much fall asleep. It was interesting. It was something else to do.

Student H: I think it was positive because it pretty much just helps you learn what to do when planning a house. Sort of like a start.

Student K: I’d say it was positive because it does teach you somewhat how to build a house and what all the steps are like to build it and how to get a permit and all that stuff.

Student C: Positive. It did teach you the really basics like different types of material you can use for different parts of the house. It was fun at first but it did get kind of boring after you did it a few times. There weren’t enough successes.

Student Q: Positive because there was a lot of stuff I didn’t know and it taught me what I didn’t know.

Student F: Positive because it got you out of the classroom and created a more fun way of learning which made it easier to remember information.

Student G: Probably positive because you got to have fun while you were learning. Something different.

Student N: It was positive for me. You were taught to do some of that stuff and still have fun at the same time.

Student O: I’d say it’s both because it taught you the basics of planning but it also missed out on some key points.
11. Would you agree that the learning environment of the gaming classroom was different from a traditional classroom?

The class population was in agreement that this was different than a traditional classroom environment.

12. How was it different? Can you explain the learning atmosphere of this class? What did you like or dislike about it compared to the learning atmospheres of other classes? What did you like or dislike about it?

Student J: It was different because you could talk to your friends about the game and stuff you were doing. If you talked you didn’t have someone getting angry at you.

Student O: There was no chalkboard or teacher’s desk, nothing scary. It didn’t feel like a learning atmosphere. It felt like a mad gaming room.

Student I: It was kind of cool because you sort of taught yourself kind of how it went. Like you would learn something and then for your next house you’d be like oh I could do that again because I know that now. And so it’s not just a teacher standing there saying read this book and this will tell you what to do or listen to me and I’ll tell you what to do. You kind of figured it out for yourself. It made you think a little more.

Student P: I think it’s a little more relaxing because you don’t have to learn at the same pace. You could go however fast you need to go.

Student H: Not scared to talk.

Student B: Seeing a visual picture and like the music in the background kind of gets you sunked to the game.
13. When you had questions about succeeding in the game how did you attempt to answer those question? Ie) research at home, ask a friend, researched within the game etc.

Student G: Our neighbors

Student J: The game library.

Student I: Experts within the game

Student K: I asked my dad what the difference between slate and asphalt was.

Student I: I talked to my mom about advertising the house. I moved a lot and my mom always read the newspaper and looked at all the different houses. She was attracted by the wording of the advertisements and explained what made them stand out.

Student P: I compared how you build the house in the game to how we’re building our house right now.

Researcher: So your family is planning a house, building a house and selling your own house. So this is kind of second hat for you. You’re doing this in real life at the same time that you’re playing the game. How does that compare?

Student P: Well real life its way, way different. There’s more detail in real life. Because when your selling a house you don’t just write up an add. You have to show home, you have to get people, get other people to tell other people, figure out in detail on exactly how much your house is worth.

Researcher: So is it comparable at all?

Student J: Yeah you have to find a lot, survey a lot, figure out where you’re going to put your house, build your house plan, frame it, do all the other stuff and then sell it. Its basically all there just not in as much detail.
14. Did anybody here talk to other people about the building game you were playing for Industrial Arts? How did they respond?

Student O: Yeah I told one of my friends that we’re doing super slack stuff in I.A. right now!

Student D: A lot of girls that I talk to ask what I do in this class. There like “Ah that would be so hard”. I was being pretty bragadocious! I was like, it’s not that bad. We’re actually having a lot of fun. We’re just playing on the computers right now building houses and stuff. They were kind of jealous.

Researcher: Students were asked for a raise of hands to get a count of who else talked about this game to people outside of this class. About half of the class (9) talked to other people about the game.

15. We’ve now finished playing the game. Some of you reached the last level of the game and some of you were still trying to get past the first level. Even though some of you didn’t successfully complete level one, do you still feel that you learned a lot about the house building and selling process?

Student J: Oh yeah, but I thought the selling part was really cheese. Like all the banks rejected the buyers. Success in the game was judged only on selling the house. We should have been judged at the end of each game phase.

Student Q: I felt like a failure.

Student P: Yeah the game wasn’t very motivating. It said something like you should never build a house in you life. Stick to doghouses!

Student C: It said like I made $30,000 but I wasn’t creative enough but creativity doesn’t really matter if you’re making money.
Researcher: Do you still feel you were succeeding even though you weren’t passing the level.

Student I: Yes, mentally

16. At this point in the game is there anything that you would like to change about the game?

Student J: Everybody to me seemed to be rejected by the bank. The offers were substantially lower than what you were asking.

Student C: The offers that I were given really varied according to what I was asking and it didn’t make to much sense.

Student I: If you could actually see inside your house. There’s a computer game called The Sims and you can actually pick out the furniture, the color of the walls and everything. It gets more into interior design.

Student J: But the Sims game you play as a person though.

Student I: Yeah but if they could incorporate that into this game. That would be awesome!

Student F: Yeah that would be cool because you could get in your truck and drive and become a real person within the game.

Student L: I’d say like in the earlier stages of the building you could factor the weather in it. Because that can prevent you from building.

Student O: I think some positive feedback would be good.

Student I: If they could sandwich the feedback. Do positive, negative and then positive. Then you would learn something and they would give you some constructive feedback.
Student G: The visuals in the game.

Student Q: It was pretty low compared to the other games we played.

Student R: Like the very first Nintendo.

17. Would you be open to using serious games for learning in the future? Why or why not?

The majority stated that they would be open to using digital games for learning. No one stated that they wouldn’t be open to serious games in the classroom in the future. All students would like to try something like this again but perhaps with a better quality game.