Gameplay in Higher Education: The Use of Serious Games vs Traditional Instructional Methods in Learning

by

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Abstract

Over the past 15-20 years, the video game industry has grown at an incredible pace. The students entering our colleges and universities, known as digital natives, have grown up with advanced technology being commonplace rather than luxury. When looking at video games, we can see elements of instruction designed in them. Additionally, we see increases in motivation and engagement when users are playing video games. Therefore, current research has theoretically proposed that video games designed around educational material can serve as effective instructional tools. These educational games and simulations are known as serious games. Although there is an abundance of theoretical data regarding the benefits of serious games, empirical data is harder to find.

This study attempted to fill some of the empirical data in regards to the benefits of serious games. The study uses three groups of students in post-secondary education classes. Each group was given instructional material covering the topic of crop domestication, but the method of transmitting the material was different (Audio Lecture, Text Reading, Serious Game). The participants took a pre-test and a post-test covering the material. Additional demographic information was gathered in order to determine differences in demographic populations using the various instructional techniques.

Results of the study showed significant learning increases in each of the three instructional techniques. The three instructional techniques were then compared against

one another. Students using serious games performed significantly worse on a post-test

examination. This suggests that although serious games can produce increases in learning,

it does so at a lower rate than other instructional techniques when applied to the

constraints of this study.

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Chapter 1

Introduction

Playing a game can be both extrinsically and intrinsically motivating (Sardone &

Delvin-Scherer, 2010). Yee (2006) suggested that this motivating factor of video games

can be used to increase student interest in a given subject. The problem, and possible

solution, of student motivation has been discussed for the past four decades. "America's

educational system suffers from motivational, scholarly, intuition-building, social-

behavior-training, evaluation, research, planning, and program-development

inadequacies. The motivational inadequacies are probably in most urgent need of repair"

(Abt, 1970, p. 16). Motivation is highly related to factors such as deep levels of learning,

recall of main ideas, elaboration, and coherence of recall of main ideas (Naceur &

Schiefele, 2005). Balduf (2009) noted that the problem of student motivation continues

to persist today. She stated that "several other aspects of participants' experiences

contributed to their college underachievement: inadequate study skills, poor time

management, and internal versus external motivation" (Balduf, 2009, p. 275). She

further suggested that "colleges should include preemptive strategies for all incoming

freshmen, including motivational and time management strategies" (Balduf, 2009, p.

275). One method that instructors are considering using to combat the problem of poor

student motivation, suggested by Abt in 1970; is the use of serious games.

Abt (1970) proposed using serious games in education to counter the increasing

motivational problems that seemed to plague the educational system at that time. He

defined serious games as "games [that] have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for entertainment" (p. 9). Coller and Scott (2009) updated the definition to include video games that were designed for entertainment and adapted to fulfill an educational objective. One recent trend in the video game market is for entertainment-based video games to be developed mimicking real world scenarios. For example, the *Civilization* franchise, a commercial game that has sometimes been adapted for instructional use, relies on multiple real-world elements such as history, politics, science, and management to create a successful gaming experience. The objective of the game is described as "players strive to become Ruler of the World by establishing and leading a civilization from the dawn of man into the space age, waging war, conducting diplomacy, discovering new technologies, going head-to-head with some of history's greatest leaders" (Firaxis Games, 2010, p. 1). With technology allowing educational objectives to be incorporated into serious games more easily than in the past, the use of games as instructional tools will likely increase in the future.

Numerous researchers have explained how serious games contain certain pedagogical elements and pedagogical techniques that can enhance student learning (Becker, 2007; Coller & Scott, 2009; Gee, 2007; Kardynal, 2009; Mansour & El-Said, 2009; McMichael, 2007; Oliver & Carr, 2009; Prensky, 2005; Prensky, 2006; Saunders, 1997; Wagner, 2008). A study that looked at factors that affected student motivation and demotivation in the classroom found that "students listed lack of teacher enthusiasm/poor presentational ability as their most frequently mentioned source of demotivation" (Gorham & Millette, 1997, p. 256). With students placing a high importance on the

motivational effects of instructional presentations, it is important to develop instructional materials that students find engaging and exciting.   This research has increased the interest in the use and development of serious games. For example, in 2009, the Obama administration allocated "at least $260-million over the next four years to help improve student achievement in mathematics and science through specially designed television programs and video games" (Basken, 2009, p. 1). With game technology advancing and investment in the development of serious games increasing, it is important to determine whether outcomes of using this instructional tool are beneficial to students.

The purpose of this study was to investigate whether or not there are any differences in student test performance after receiving instruction via audio lecture, text reading, or serious game. A second purpose of this study is to investigate whether or not there is a difference between test scores among select student demographic categories after receiving instruction via a serious game. The focus was on undergraduate students in higher education. This study will contribute to the research determining whether or not serious games can enhance the delivery of instructional material and which students benefit more from their use.

Statement of the Problem

Many instructors have failed to adapt to emerging instructional technologies that today's students desire. "Our students are no longer the people our educational system was designed to teach" (Prensky, 2005, p. 98). More and more students are becoming disengaged with the education system.   The retention rate of first-time college freshman returning for their second year, at four year institutions, has declined between the years 2004 through 2008 (NCHEMS, 2008). A number of factors are attributable to whether or

not an individual student will persist in higher education, including social and academic

interactions (Tinto, 1994). One of the academic factors is motivation to learn. Research

has shown that "relative to general motivational measures, academic-specific

motivational measures better predicted academic performance" (Robbins, Allen, Casillas,

Peterson & Le, 2006, p. 612). Therefore, if instructors can motivate students in the

classroom and make their instructional content more engaging, they will have a better

chance at increasing their students' academic performance and retention.

Today's traditionally aged college students enjoy playing video games more so

than past generations. This is evident in the increasing popularity of gaming over the past

quarter century. The amount of money spent on purchasing video games has nearly

tripled from $2.6 billion dollars in 1996 to approximately $10.5 billion dollars in 2009

and the number of video game units sold has increased from 73.3 million units in 1996 to

273.5 million units in 2009 (Entertainment Software Association, 2010). With these

numbers likely to continue expanding, educators should consider the motivational impact

of games in their instruction. By incorporating characteristics of games with instructional

material, the potential for motivating students to learn may increase, as well as improving

the chances that students will perform at higher academic levels.

Theories addressing the benefits of games in the classroom have emerged along

with the rise in popularity of video games in contemporary culture. Prensky (2001, 2005,

2006) has argued repeatedly that the characteristics of younger generations indicate that

students would thrive in learning environments that include serious games. Qualitative

research conducted by Squire (2004) suggested that students in a history class were more

engaged in the content when using the game *Civilization III* along with traditional

instructional techniques. Other findings from research about the use of serious games include increasing social interaction (Oliver & Carr, 2009), benefits due to experiential learning and constructivism (Dieleman & Huisingh, 2006; Saunders, 1997; Wagner, 2008), and increases in cognitive learning achievement (Chuang & Chen, 2009). This study further investigates the effects of serious games on learning, including any possible benefits or pitfalls.

When compared with the amount of literature on traditional learning, gaps exist in the empirical research investigating serious games. These studies are much fewer when compared with the amount of literature on traditional learning. The study presented here is an empirical investigation attempting to determine the effectiveness of serious games compared to the traditional instructional methods of lecture and reading. This effort will advance the research in the use of serious gaming in education. Moreover, this study will compare the differences in test scores of students taught using either a serious game, audio lecture, or a text reading. Additionally, demographic information was collected to determine whether or not differences exist in the test results of different types of students when using serious games. The goal was to determine whether or not serious games should be considered an effective instructional tool.

<center>Purpose of the Study</center>

The purpose of this study was to determine the effectiveness of serious games as an instructional technique. This study compared the differences in student scores following an instructional session. Specific comparisons were made between the instructional techniques of audio lecture, textual reading, and serious games. Demographic information was collected and compared to determine whether certain

<center>5</center>

students perform better than others using each instructional technique: serious game, audio lecture, and text reading.

Research Questions

1. What are the differences in student test performance upon the completion of one of the following instructional techniques: audio lecture, text reading, or serious game?

2. What is the relationship, if any, among demographic variables (ethnicity, gender, game-play frequency, academic discipline, and preferred learning style) and student test performance among each of the instructional techniques?

Statistical Hypothesis

1. There is no significant difference in student test performance upon completion of audio lecture, text reading, or serious game play.

2. There is no significant relationship between demographic variables and student test performance among each of the instructional techniques.

3. There is a significantly greater student test performance improvement using the instructional technique serious game play.

4. There is a significant difference in student test performance by gender among the instructional techniques.

5. There is a significant difference in student test performance by ethnicity among the instructional techniques.

6. There is a significant difference in student test performance by frequency of game play among the instructional techniques.

7. There is a significant difference in student test performance and academic discipline among the instructional techniques.

8. There is a significant difference in student test performance and preferred learning styles among the instructional techniques.

Significance of the Study

Identifying whether or not serious games are associated with increased scores on academic assessments when compared to traditional forms of instruction will contribute to the research literature about pedagogies that academic professionals use for teaching students. If serious games are found to significantly improve student learning, implementation of acquiring strategies in instruction will benefit students and their academic achievement. However, if serious games are found to have no impact on student learning, then the high development costs of such instructional tools could be avoided and reassigned to more productive methods of teaching. Ultimately, this study will contribute to the growing body of literature surrounding the subject of serious games and education.

Assumptions

The following assumptions are relevant to this study:

1. Sample of students involved were representative of the larger population (normal distribution and equal variances).

2. Participants in the study have prior knowledge of geographical regions of the world, which is a portion of the subject matter used in the study.

Limitations and Delimitations

This study was delimited to undergraduate students at a large public research university in the southeastern United States. Additionally, participants voluntarily chose to participate in the study and, therefore, the results can only be generalized to students with similar characteristics.

This study was also delimited to the subject of the instructional material. The instructional material and instruments used in this study focus on crop domestication in the field of agronomy and soils. Although steps to control for prior knowledge of the subject area were taken, the possibility still remains that prior knowledge of the subject could affect the generalizability of the study.

Definitions

The following are definitions of terms used in this study:

Constructivism: learning theory that states learner's construct understanding or meaning by making sense of their experiences and fitting their own ideas into reality (Schulte, 1996).

Digital Native: students that are "native speakers" of the digital language of computers, video games and the Internet and were raised with a strong dependence on technology (Prensky, 2001).

Experiential Learning: The process whereby knowledge is created through the transformation of experience (Kolb, 1984).

Hypertext Mind: the ability developed by digital natives of being able to quickly combine partial information from multiple data sources in order to determine the meaning of a topic (Prensky, 2005).

Massively Multiplayer Online Game (MMO or MMORPG): "massive" multiplayer, refers to groups of from several hundred thousand to up to one million all online and playing at once. The games that support this, such as *EverQuest, Ultima Online, Asheron's Call* and *Dark Age of Camelot* in the US and *Lineage* in Korea, (with new games arriving frequently) are phenomena in which hundreds of thousands of players are online simultaneously. Their basic goal is character improvement, which is often achieved though cooperation to achieve common goals. This type of game, usually set in a "persistent" world which goes on even when a player leaves, is extremely addictive and time-consuming for many, and spawns an entire economy of tools and tool building and buying and selling on the periphery of the game. Millions around the world pay a monthly fee to play. The "role playing" games are known as MMORPGs. There are also other types of massively multiplayer online games, such as The Sims Online, or America's Army which are played by equally large numbers of people, but in smaller groups at one time (Prensky, 2003).

Second Life: A virtual world on the Internet from Linden Research, Inc., San Francisco, CA (www.lindenlab.com), in which "residents" create an identity, meet people, buy land and build their own environment or purchase an existing one. It is a "massively multiplayer online role playing game" (MMORPG), but one that offers users total freedom to create and interact as if they were living another life (Davis, 2010).

Serious Game**:** an activity involving skill, chance, or endurance on the part of two or more entities that perform according to a set of rules and which the content of the activity can be used in an educational situation (Abt, 1970).

Student-Centered Instruction**:** focus is on both the instructor and the student. Instructor facilitates designed instruction incorporating student interaction. Students have some choice in topics and both students and instructors are responsible for student evaluation. Large amounts of student-to-student interaction (NCLRC, n.d.).

Teacher-Centered Instruction**:** focus is on the instructor. Instructor disseminates information to students. Instructor chooses topics and evaluates students. Instructor answers student questions. Little student-to-student interaction (NCLRC, n.d.).

Virtual World**:** a synchronous, persistent network of people, represented as avatars, facilitated by network computers (Bell, 2008).

Organization of the Study

This study is organized into five chapters. Chapter 1 is the introduction. This chapter discusses the statement of the problem, purpose of the study, research questions, significance of the study, limitations, delimitations, assumptions, and definitions regarding the study. Chapter 2 consists of a review of the literature. Chapter 3 provides information related to the population and sample, research design, data collection procedures, validity and reliability, field testing of the survey instrument, and the procedures for the analysis of the data. Chapter 4 reports the findings in relation to the research questions. Lastly, Chapter 5 provides conclusions and discussion based on the findings and recommendations for further study and practice.

Chapter 2

Literature Review

Introduction

Technology is reshaping the way we educate our students today. For example, computers have become ubiquitous in classrooms. Chalkboards are being used less as instructors become more efficient at using electronic presentations and "smart" boards. Course management systems and the Internet have allowed for greater learning at a distance and often supplement instruction. Interactive devices and technologies such as "clickers" are changing pedagogical techniques used by instructors in classrooms. With newer teaching tools being introduced more frequently, the use of serious video games is another tool that is becoming more prevalent. The purpose of this study was to determine the effectiveness of serious games as an instructional technique. This study compared the differences in student scores following an instructional session. Specific comparisons will be made between the instructional techniques of audio lecture, textual reading, and serious games. Demographic information will be collected and compared to determine whether certain students perform better than others using each instructional technique: serious game, audio lecture, and text reading. The research questions were:

1. What are the differences in student test performance upon the completion of one of the following instructional techniques: audio lecture, text reading, or serious games?

2. What is the relationship, if any, among demographic variables (gender, game-play frequency, etc.) and student-test performance among each of the instructional techniques?

Serious games hold many of the same characteristics that allow simulations to enhance student learning, such as helping to make meaning of complex tasks and developing critical thinking skills (Clapper, 2010). There have been numerous studies over the past quarter-century that demonstrated how simulations work and improve learning (Canon-Bowers, 2006).

Kee, Grahm, Dunae, Lutz, Large, Blondeau, and Clare (2009) suggested that games such as *Civilization III* should be utilized in the classroom to initiate and enhance discussions regarding world history. Gaber (2007) also gave an example of how the video game *SimCity* can be utilized in city planning courses and increase discussion in the classroom about systems planning. These are two examples where the use of serious games points to better student engagement and student learning.

Several researchers have described how serious games have the potential to improve student learning. Prensky (2005) explained that educational games allow students to progressively achieve deeper understanding of content and concepts. Prensky reported multiple levels of learning that occur as students interact with a serious game, which he described as how, what, why, and change. First, students interacting with a game or simulation learn how to do something. They memorize and learn how to mimic a task or they learn how to interact with the game system. Second, they learn what to do. Typically, a story is developed in the game and the player progresses through stages as they become more engaged with the system. Eventually, higher levels of learning are

reached as students learn why to interact with certain aspects of the system. Students

learn about cause and effect, long term winning versus short term gains and second order

consequences. The fourth level of learning is when the student needs to interact with the

system in order to make changes occur. This allows the student to utilize the

relationships they have learned thus far in order to manipulate the game. Finally, the

student learns the concepts of when to take appropriate action and whether or not an

appropriate action is justified. This is the highest level of learning in a game because it

requires emotion and ethical consequences to certain actions performed in the system.

Although Prensky (2005) never suggested that a serious game should replace an

instructor for teaching purposes, he does make the argument that it could be a useful

instructional tool that is beneficial to a student's overall learning. McMichael (2007)

described the long process he went through as he attempted to select various commercial

video games that he could incorporate into his world history curriculum. Although he

describes the process as worthwhile in the long run, incorporating a game into a course is

often time consuming. However, McMichael ultimately felt that the effort was

worthwhile because the experience was beneficial to his students.

In order to determine the validity of serious games as an effective instructional

technique, a review of the current literature on the subject will be conducted. First, a

brief history of the evolution of early serious games will be discussed. Second, a brief

description of the theories serving as the conceptual basis for this study will be provided.

The framework will revolve around Bloom's Taxonomy of Educational Objectives and

Gagné's Events of Instruction. Third, the review will focus on the current generation of

students entering secondary and post-secondary education, in order to determine whether

or not they will be receptive to use of serious games in an educational setting. Next, the

review of literature will focus on educational and instructional theories in order to

surmise whether or not serious games can serve as effective teaching tools. Finally, a

search of empirical data on the subject will be conducted in order to determine whether or

not current studies have validated the use of serious games as pedagogical tools.

History of Serious Games

Games have long been part of human culture. This is evident by the archeological

finding of the Royal Game of Ur. "The two boards date from before 2600 BCE. Each of

the game boards is composed of a set of twelve squares and a set of six cases linked by a

bridge of two cases" (Soubeyrand, n.d., p. 1). Although games have persisted throughout

the years as entertainment outlets for humans, the early uses of games as instructional or

training tools tended to focus more on military aspects rather than purely educational

aspects. Halter (2006) explained,

> Though the goals and rules of each game may differ, they share a similar
> form. Each requires the use of a set of game pieces – typically of different
> colors – that represent soldiers in an army, and a game-board grid that may
> be thought of as a miniature battlefield. In each game, two players employ
> a series of prescribed movements to outdo the other player's army,
> whether by surrounding his or her pieces, capturing, or removing them
> from the board, or controlling the space on the imagined war-grounds. (p.
> 6-7)

Although the concept of serious games is thought of as a recent concept due to

advances in technology and game mechanics, the originations of these games can be

found throughout history. Although the games of *Go*, Chess, and Kriegsspiel were

developed well before the digital era, evidence suggests that these games may have been

developed and used as military training devices (Livermore, 1882; Mihori, 1939; Shenk,

14

2006). Therefore, these three historical games would be considered some of the first

serious games.

The game of *Go*, also called *weiqi*, is believed to have originated thousands of

years ago somewhere in India, China or another area of the East (Mihori, 1939). Halter

(2006) described the game:

> The game takes place on a large grid, and where each player sets down a
> series [of] small, smooth stones, either black or white. Players attempt to
> control the greater part of the grid, and in the course of doing so, can
> surround the other's stones and capture them. (p. 19)

Go has survived over 1,000 years and remained a popular cultural icon in eastern Asian

countries, especially Japan. Mihori (1939) explains that the popularity of *Go* in Japan

eventually led to the development of a great institution known as the Japan *Go*

Association.

Although the origin of the game of *Go* is lost to history, Mihori (1939) explains

that the most accepted account of its development is credited to the Chinese Emperors

Yau and Shun. The story unfolds by describing that the sons of both emperors were

unwise. Therefore, the emperors developed the game of *Go* as a means of leading their

sons along the path of wisdom. Consequently, according to this account, the game of *Go*

would serve as one of the first serious games since the game was designed not for

entertainment, but rather to instruct people and teach them the ways of wisdom.

Go is not the only ancient game that was used as a serious game. The game of

Chess can also be considered a serious game. Although the origins of Chess seem to

have been developed in India, Shenk (2006) noted that the game developed as "the result

of years of tinkering by a large, decentralized group, a slow achievement of collective

intelligence" (p. 17). Shenk pointed out that the game may have been originally

developed to enhance the debate regarding man's dependence on destiny and fate. He

also described Chess as follows:

> It used the highly accessible idea of war to convey far less concrete ideas.
> Chess was, in a sense, medieval presentation software – the PowerPoint of
> the Middle Ages. It was a customizable platform for poets, philosophers,
> and other intellectuals to explore and present a wide array of complex
> ideas in a visual and compelling way. (p. 17)

Therefore, although it is a game, it appears that Chess also served as an instructional tool.

Consequently, Chess follows in the footsteps of *Go* as one of the first serious games.

Kriegsspiel, also known as war gaming, was developed in the early 1800's and

designed to accurately portray and simulate battlefield scenarios. Halter (2006)

described how Herr von Reisswitz's version of the game incorporated rules and pieces to

accurately simulate the complex military structures of the day. He stated,

> [Herr von Reisswitz] discarded the impressive but impractical Chinese
> puzzle of terrain blocks, bringing in modern topographic maps of true
> landscapes, scaled at about eight inches to the mile. The porcelain pieces
> were switched out for metal figurines, also the same scale, standing in for
> infantry, cavalry, and artillery. He colored the two challenging armies red
> and blue (a convention that famously persists to this day in a variety of
> military exercises); each contender moved his pieces in two-minute turns,
> but was limited to covering a distance equal to what rue troops could
> march in the same time. An umpire determined the results of each melee,
> employing dice and statistical tables based on data gleaned from military
> history; the umpire thus established not only the victor, but how many
> men were lost on each side as a result. (p. 41-42)

Although Kriegsspiel began as a game for Prussian elites, the game quickly spread

through military academies in Prussia following the changing culture in the Prussian

army following their severe trouncing at the hands of Napolean (Halter, 2006).

Kriegsspiel began as a German fascination and the game spread to other major

military powers by the end of the nineteenth century. Halter (2006) explained that "up

through the mid-1800's, war gaming remained a primarily German pursuit. But after

German victories against Austria in 1866 and France in 1871, the other European powers

developed a keen interest in Prussian military practices" (p. 45-46). This sentiment is

echoed by Livermore (1882) when he described the evolution of Kriegsspiel as "ouside

of Germany, for a long time the game was regarded with little favor. After the War of

1866, however, it was cultivated extensively in Austria and the War of 1870 opened the

eyes of all Europe to its importance" (p. 2). Eventually, after the game migrated to the

United States, Livermore (1882) stated that "in the United States it has been played to a

limited extent since 1867, and its popularity has increased with the reputation of the

Germans as a military nation" (p. 2). When adapting the game for use in the United

States military academies, Livermore (1882) explained that "the Kriegsspiel or War

Game is the first which has carried this resemblance [to the operation of war] far enough

to answer the purposes of military instruction" (p. 1). By utilizing the war game for

training purposes, Kriegsspiel stands with *Go* and Chess as one of the earliest serious

games developed.

      With technological advances such as microcomputing rapidly occurring in the last

century, the development of serious games has expanded. Serious games have emerged

from their historical foundations as military training aids and entered the realm of

contemporary education. As shown in Table 1, serious games in education have shown

promising results thus far, but it has been also recommended that more research be

conducted (Lemke, Coughlin, & Reifsneider, 2009).

Table 1

Research in Learning through Video Games

	Internal Mental Process				
	Basic Skills	Higher Level Thinking	Information, Communication, & Technology (ICT)	Collaboration / Participatory Learning	Engagement in Learning
Experimental or Quasi-Experimental	+	+ -		+	+
Correlational or Descriptive/Correlational	+		+	+	+

Note. "+" indicates primarily promising findings, "+ -" indicates mixed findings (Lemke, Coughlin, & Reifsneider, 2009, p. 13-15).

Conceptual Framework for the Study from Literature

Bloom, Engelhart, Furst, Hill and Krathwohl (1956) defined a classification system of educational goals known as Bloom's Taxonomy. Bloom et al. (1956) described the taxonomy as a hierarchy, stating, "As we have defined them, the objectives in one class are likely to make use of and be built on the behaviors found in the preceding classes"(p. 18). Therefore, before a student can reach class six, known as evaluation, they must build upon the concepts acquired through classes one through five. Because of this hierarchy, the research in this study focused on a single level in Bloom's Taxonomy. The knowledge construct, which is class one in Bloom's Taxonomy, is defined as "those behaviors and test situations which emphasize the remembering, either by recognition or recall, of ideas, material, or phenomenon" (Bloom, et al., p. 62). Ultimately, this study was designed to determine whether or not a serious game enhanced the recall of knowledge by a student as defined in this first level of Bloom's Taxonomy.

A second driving theory influencing this study is Robert Gagné's (1985) "events of instruction." Gagné developed a nine step theory of instruction designed to teach people selected educational objectives. In Gagné's events of instruction, he notes that the learning and encoding of information occurs in the first five steps. This is observed when Gagné describes step six, saying

> The instructional events so far described are designed to assure that learning "takes hold." The new capability reflected in the objective, whether verbal information, intellectual skill, cognitive strategy, attitude, or motor skill, has been encoded into a form for storage in long-term memory. It is then time for the learner to demonstrate the newly learned capability. (p. 254)

Gagné later defines knowledge retention as the probability that what has been learned will be held over long periods of time (p. 255). With this distinction in mind, this study focused on Gagné's definition of learning rather than retention. Therefore, the emphasis here is on knowledge obtained at one point in time rather than knowledge held over longer periods of time, as described in the first five steps of Gagné's events of instruction.

While keeping the work of both Bloom and Gagné in mind, the first area of literature that needs to be considered is research determining whether or not today's cohort of students would accept serious games as an instructional tool. Moreover, the literature needs to be reinvestigated to see if serious games would be beneficial to students.

<div align="center">Characteristics of Millennial Students</div>

Today's undergraduate population at institutions of higher education consist of "digital native" students, or those students that are "native speakers" of the digital language of computers, video games and the Internet and were raised with a strong

dependence on technology (Prensky, 2001). This cohort of students is known by many different names including Generation Y, the Millennial Generation, the Net Gen, and the Dot Com Gen. Prensky (2005) suggested that a "singularity" has occurred between today's students and students and teachers of the past. He defines this singularity as "an event that changes things so fundamentally that there is absolutely no going back" (Prensky, 2005, p. 98). Prensky doesn't specify whether this singularity was a technological and pedagogical singularity; however, this singularity has created a technological divide between today's students and the older faculty members and past student cohorts, which he calls "digital immigrants." Digital immigrants are those individuals who grew up prior to the technology singularity of the late twentieth century and did not grow up reliant on technology (Prensky, 2005).

Prensky (2005) pointed out that the changes that have occurred in digital natives are not the typical aesthetic or philosophical changes that typically occur between generations. He stated that "today's students have not just changed incrementally from those of the past, nor simply changed their slang, clothes, body adornments, or styles, as has happened with previous generations" (Prensky, 2005, p. 98). Rather, Prensky suggested that, due to the technological revolution experienced in our culture, multiple core characteristics of today's and tomorrow's students have changed. Howe and Strauss (2000) have also pointed out that core characteristics have changed within the new generation of students, and that this needs to be taken into account. Some of the characteristics that define these newer generations of students include the need to feel special, being overly sheltered and protected, being extremely confident, preferring team-

oriented activities, being over-achieving, feeling highly pressured, and being generally conventional (Howe & Strauss, 2000).

With these multiple characteristics that uniquely define current and future students, the probability exists that "our students are no longer the people our educational system was designed to teach" (Prensky, 2005, p. 98). Teacher-centered instruction, which has been the hallmark of pedagogy in the past, will likely need to be re-evaluated when looking at contemporary student populations. Learner-centered paradigms of instruction, such as constructivism, where learning learner's construct understanding or meaning by making sense of their experiences, are better suited to the characteristics of today's students (Huba & Freed, 2000). Further exploration of these paradigms would seem prudent in order to determine whether or not they are more beneficial in educating today's students. Prensky (2005) stated, "the single biggest problem facing education today is that our Digital Immigrant instructors, who speak an outdated language (that of the predigital age), are struggling to teach a population that speaks an entirely new language" (p. 98).

One pedagogical tool that seems to fit well with the newly emerging cohorts of students is the use of serious games. Students of the digital native cohort are already familiar with video games and enhanced simulations. "Playing video games is an especially prominent leisure activity of children and young adults" (Olthouse, 2009, p. 2). A report by Riley (2008) suggested that there are over 56.8 million U.S. consumers reported having played a game on a social network. Additionally, a study in the United Kingdom showed that 85% of children polled played computer games multiple times a week (Sandford, Ulicask, Facer, & Rudd as cited in de Freitas, 2006). Prensky (2006)

calculated that "today's average college grads have spent fewer than 5,000 hours of their lives reading, but often more than 10,000 hours playing video games, another 10,000 on their cell phones, and more than 20,000 watching TV" (p. 27). It is clear that today's generation of students is attracted to video games. Consequently, since this phenomenon has captured the attention of our younger students, it has already fulfilled part of the suggested elements of a good instructional tool (Gagné, 1985; Gagné & Briggs, 1979).

In order to determine whether or not serious games are a suitable medium for learning, we must first determine if the features found in serious games match the educational and learning characteristics that students have and thus, stay motivated and engaged. To do this, some of the key traits of digital natives will need to be examined. These traits include digital literacy, information efficiency, socialization and teamwork, pragmatic views, and graphics and aesthetics (Howe & Strauss, 2000; Oblinger, 2003; Prensky, 2005).

Digital Literacy

The typical digital native understands and is adept at using technology. From their earliest days, today's children are inundated with various forms of technology. A device suggested for children aged 6 to 36 months old is the *Learning Music Player*. The device works by "pressing buttons to scroll through and choose songs. Skip forward, back and even pause songs, all while fun character friends dance on the screen" (Mattel, Inc., 2009). As the child gets older, they begin to use other interactive devices that incorporate entertainment and education such as the *Leap Frog* educational products (LeapFrog Enterprises, Inc., 2009). Finally, between their adolescent and adult years,

young people are introduced to an abundance of technological devices such as cell phones, computers, gaming consoles, iPods and more.

Warshauer (2007) pointed out that while today's youth have gained the ability to multitask with digital technology such as computers, video games, cellular phones and more, today's teachers have had a harder time adapting. "Today's teachers did not grow up using computers, the Internet, and other digital media on a daily basis" (Warshauer, 2007, p. 149). This has resulted in a generational gap in the use of technology. The digital immigrants of past generations need to adapt to this new environment because they currently speak a different technological language than that of the digital native students (Prensky, 2005; Prensky, 2006). One area that digital immigrant instructors need to adapt to are new pedagogical methods because "their teaching style, which likely reflects the way they were taught as children, may not match well with the learning styles of their digital native students" (Warshauer, 2007, p. 150).

Prensky (2005) suggested that digital natives have enhanced digital literacy due to the environment in which they have been raised. He suggests that since digital natives were the first generation to experience the non-linear form of information gathering that the Internet offers, younger students may develop "hypertext minds" (Prensky, 2005, p. 99). It is suggested that students no longer need to follow a linear structure of education because they have developed the ability to randomly access multiple sources of data that they feel are relevant to the issue at hand (Prensky, 2005). However, Oblinger and Oblinger (2005) pointed out that this change in learning capabilities has negative aspects associated with it as well. She pointed out that "although [digital natives] are comfortable using technology…their understanding of the technology or source quality

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may be shallow" (Oblinger & Oblinger, 2005, p. 2.5). Thus, today's students who utilize

random access thinking via digital literacy may indeed allow for more information to be

assimilated, but the data may lack quality and depth of understanding about the topic.

If Prensky's (2005) idea on random access thinking versus linear thinking holds

true, serious games may provide a better learning option for students. Since many games

are designed to allow for multiple paths towards successfully completing various

objectives, students are afforded the opportunity to piece together information found

throughout different modes and methods. Therefore, the type of networked information

found in serious games matches well with the digital native characteristic of random

access thinking.

Social Interaction / Teamwork

Today's students desire social interaction in and out of the classroom setting

(Monaco, 2007). "With the advent of the Web, millions of children around the world are

routinely gathering online to chat, sometimes to discuss a common interest, such as sports

or the guitar, but often with no specific purpose to the conversation" (Tapscott, 1998, p.

56). Oblinger (2003) found that staying connected is essential for digital natives. She

explained,

> Students stay in touch, via multiple devices, as they move throughout the
> day. Cell phones, PDAs, and computers ensure they remain connected
> anyplace and anytime. As the network becomes more ubiquitous,
> increasing numbers of students participate in real-time dialogues from
> anywhere using a variety of devices. (p. 40)

Prensky (2006) pointed out that the desire to stay in touch has led to the adoption of the

cell phone as an essential tool for digital natives. In recent years, the rapid expansion and

acceptance of social networking websites such as Facebook, Myspace, and Linkdin have

allowed individuals to easily and efficiently maintain contact with members of their social network. The characteristic of enhancing social interaction is no longer limited to individuals who have met face-to-face. Tapscott (1998) described the birth of virtual communities where individuals will communicate with each other and build a sense of friendship and community, yet they will never meet each other face-to-face.

Related to the digital natives' desire to engage in social interaction is the idea that digital natives prefer group work and teamwork activities rather than individual tasks and assignments. "Collaborative learning has become as popular as independent study was for Boomers or open classrooms for Gen Xers" (Howe & Strauss, 2000, p. 155). Kraus and Sears (2008) determined that a majority of undergraduate students surveyed tended to enjoy collaborative pedagogical techniques and assessments such as class discussion and projects more so than techniques that isolated learners. However, when engaging in group activities or teamwork in order to accomplish a task, students prefer to choose groups of their peers rather than be randomly assigned to a group. Howe and Strauss (2000) explained that team ethic is an important factor when individuals choose their friends. They stated that "honesty and hard work are now the highest-valued personal qualities" (p. 181).

Howe and Strauss (2000) also suggested that current and future cohorts of students are under more pressure to succeed than those of the past. Monaco (2007) explained that this increased pressure to succeed is a primary factor in the digital native's preference for team oriented work. "Independent work has a higher risk of personal failure and therefore, [digital natives] are not as confident in working alone. As a result, students prefer to work cooperatively on projects and participate in collaborative group

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settings" (p. 43). DeBard (2004) echoed this sentiment by stating that "being a member of a team lowers the pressure on individuals" (p. 37). Whether the desire to work in groups has developed from a need for social interaction or a mitigation of individual pressure, it's clear that digital natives prefer group over individualized work.

One reason that commercial video games have grown in popularity is by incorporating the idea of social relationships. Along with realism, these are the most important video game qualities for gamers today (Golub, 2010). Many video games now have multiplayer modes that allow peers to either interact cooperatively, competitively, or a mixture of both. A study of 1,000 gamers conducted at the University of Rochester showed that achievement, freedom, and a connection with other players were important motivators for playing games (Dickman, 2006). This is evident in the rapid expansion of massive multiplayer, online role-playing games. This genre of video games is evidence of the ability of games to capitalize on a cooperative team work model. Games such as *World of Warcraft, EverQuest,* or *Lord of the Rings Online* allow thousands of people to simultaneously interact and work with each other to advance through the game. James Gee (2007) described it as follows:

> In these games you can often choose to play in a world where the monsters (not real people, but characters controlled by the computer and endowed with artificial intelligence) are the only bad guys and other players cannot kill you (and you can't kill them). Or you can choose to play in a world where you can kill and be killed by other players as well as the creatures that inhabit the countryside. (p. 180-181)

These games encourage interaction and team work with others in order to overcome tasks that become increasingly difficult. The game forces cooperative play by creating obstacles that are too difficult to overcome without team work. "Bands must develop strategies that capitalize on individual strengths, and communicate with each other as

they carry out their plans, in much the same way that athletes in team sports must rely on each other to win" (Olthouse, 2009, p. 3). The drastic increase in online gaming subscribers suggests that players seem to accept and enjoy this system of forced interaction. In September 2006, it was announced that "World of Warcraft has hit 7 million active subscribers world-wide" (Harper, 2006, p. 1). Of course, this means that over 7 million people pay monthly fees to interact with one another in a virtual world.

Serious games can also use group work and social interaction to engage digital natives in higher levels of learning. Mansour and El-Said (2009) suggested that educational games "play a vital role in promoting social interaction among students. The use of serious games may encourage discussion, involvement, and collaboration" (p. 229). They conducted a study at the University of Louisville to determine the effect that serious games had on promoting social interaction among students. In the study, most of the students claimed that interacting in the educational game resulted in increased interaction and had an overall positive effect on their relationship with classmates. Additionally, they stated that "playing the game facilitated collaboration and communication among students which in turn enhanced their learning performance" (p. 236). Ultimately, these findings showed that incorporating elements of social interaction and collaboration in educational games can result in enhanced learning experiences for digital native students.

Technology has allowed digital natives to interact with their peers in a quicker and more efficient manner. The corporate gaming market has already started using this characteristic of digital natives in the development of their video games. Educational institutions could also engage students by using serious games to appeal to their desire of

teamwork since these instructional tools already use aspects of collaboration and social networking (Connolly, Stansfield, Hainey, Cousins, Josephson, O'Donovan, Ortiz, Tsvetkova, Stoimenova, & Tsvetanova, 2009).

Information Efficiency

Due to the rapid pace of technological innovation and improved information network capabilities that digital natives have become accustomed too, this generation has developed the ability to search through and assimilate information at a rapid pace compared with digital immigrant learners and instructors (Berk, 2010). While digital immigrants learned through a linear structure such as reading a book from beginning to end, digital natives have learned to acquire information by combining a myriad of information sources through linking and networking. Tapscott (1998) explained that "information is input from multiple sources and occurs in a less sequential manner. Using software, the child can organize information into complex structures containing links to other information systems" (p. 103). This ability to navigate through the vast amount of knowledge available has led to positive outcomes including the ability to multi-task and an increased aptitude for examining the validity of information.

Multitasking is natural for digital natives (Tapscott, 2009). They no longer follow the traditional methods of conducting work by focusing on one task with minimal or no distractions. Tapscott (2009) also reported that a Harris Interactive survey showed that, while digital natives are performing a given task online, "53 percent listen to MP3s, 40 percent talk on the phone, 39 percent watch TV, and 24 percent do their homework" (p. 42). Alsop (2008) echoed this sentiment by describing the digital native student in a working environment. He describes this type of student as disappointed when they are

unable to listen to their MP3s while at work. Oblinger and Oblinger (2005) further emphasized this point by stating that digital natives "multitask, moving quickly from one activity to another, sometimes performing them simultaneously" (p. 2.6). Ultimately, digital natives are more likely to focus on multiple subjects and tasks at any given time rather than focus on a single task.

The information overload present today has forced students to enhance their ability to filter out bad information. Prensky (2006) described the process that students undertake when they go about searching for information. Although they may still use traditional methods of searching for information in a book or journal, digital natives primarily search for information via digital search methods such as search engines. He suggested that typical search engines can find anything from phone numbers to satellite maps. Talpscott (2009) expanded this thought and suggested that digital natives have developed a greater sense of scrutiny. He explained that "given the large number of information sources on the Web, not to mention unreliable information – spam, phishers, hoaxes, scams, and misrepresentations – today's youth have the ability to distinguish between fact and fiction" (p. 80).

Video games have the ability to tap into this sense of multitasking and information filtering. Video games provide players with an abundant amount of information through the game in order to allow the player to make a decision on how to proceed in the game. Illustration 1 shows a screenshot of the first-person shooter action game Battlefield 2. On the screen, the player has multiple sources of information to observe. At any given time, the player can focus on the action directly in front of his character, the status of his teammates around his location (displayed in the circular map

in the top right corner), his current weapon and ammunition level (displayed in the

bottom right hand corner of the screen), his current remaining life (displayed in the lower

left hand corner of the screen), and information regarding the current game itself

(displayed as text messages in the upper left hand corner of the screen). While taking in

all of this information, the player can also receive verbal commands from his teammates

over the computer speakers or through a headset. The player is required to filter out the

needed information in order to complete a given task. Once the player has filtered the

information, he or she will make a decision and proceed through the game. For example,

the player will need to determine whether or not his health, ammunition, and status of

teammates in his area warrant him pushing forward or maintaining his position. This

entire process occurs within a matter of seconds.

Illustration 1. Screenshot of the video game Battlefield 2 (© 2005) by Electronic
Arts in which the player has multiple information displays that they are required to
utilize simultaneously.

Although the Battlefield 2 example is just a single scenario describing the ability of video games to utilize the digital native characteristic of obtaining information more efficiently, it demonstrates how these systems can arrange an overwhelming amount of information into chunks that promote learning and decision making. Digital natives have been able to develop techniques to allow them to filter and chunk these large amounts of information into comprehensible units (Berk, 2010).

Pragmatic View

"Students are consistently looking for practical applications of their studies in a real-world context" (Windham, 2005, p 5.8). Due to the rapid pace of changing and emerging technologies in today's world, digital natives may be worried that the information that they learn may or may not be relevant by the time they enter the workforce. This pessimistic view has led digital native students to view their education through a very pragmatic lens. Since the potential of newly emerging skills could affect the job market, digital native students have become very impatient. They expect to be able to successfully complete school and maneuver up the corporate ladder at a relatively young age (Alsop, 2008).

Surveys conducted by various organizations and reported in Tapscott's (1998) work showed digital native students frequently lost interest while doing a web search if a website didn't quickly supply the information desired or took too long to respond. One example stated that the participants would hesitate from going more than two pages away from the initial search page. With the abundance of information available, students feel it is more efficient for them to redefine their search terms rather than search for the information within various documents (Tapscott, 1998).

Video games employ pragmatic principles that are desired by digital natives. Every function of a game pushes the player towards the ultimate goal of winning the game. Therefore, each action by the player has the pragmatic function of continuing on the track towards victory. Additionally, this information must be delivered to the player in a timeframe that maintains the player's interest. "If a player cannot easily determine what he or she needs to do in a given situation, the player will become frustrated and eventually give up" (Becker, 2007, p. 28). Whether or not it is playing a game or gathering information, digital natives tend to lose interest if they don't see the pragmatic value of what they are doing or if they don't gather the desired knowledge in what they view as a reasonable time frame.

Graphics and Aesthetics

"The hazard of watching everything in HD is that everyone in your household over the age of 7 becomes a video snob" (Carnoy, 2009). Prenksy (2005) stated that previous generations generally viewed graphics and illustrations as supplemental material for the text that they were reviewing. However, when it comes to digital natives, "the relationship is almost completely reversed: the role of text is to elucidate something that was first experienced as an image" (Prensky, 2005, p. 100). This newly developed expectation of graphic and aesthetic appeal produces new challenges when it comes to gaining and retaining student attention in the classroom.

Tapscott (2009) suggested that "digital imimmersion may alter Net Gener's visual systems" (p. 106). He further explained that digital natives have grown up becoming accustomed to icons and visual interfaces associated with the technology they use and that this phenomenon is what has led digital natives to be more reliant on visual imagery

compared to text based information. Hartman, Moskal, and Dziuban (2005) emphasized

this, suggesting that "today's graphical user interfaces and the Web make the operation of

computers highly interactive and achievable by nearly everyone" (p. 6.2). Dave Roos

(2007) also pointed out that

> One study examined a library class at California State University – Hayward,
> where students frequently ignored lengthy text directions for homework
> assignments. When the assignments were rewritten using images first, student
> scores increased by 11 to 16 percent and refusal to complete the assignment
> dropped by 10 to 14 percent. (p. 2)

Furthermore, the University of Southern California's Leavey Library redesigned their

mostly text based website in order to incorporate a large amount of graphic and visual

cues so that students could better locate and assimilate pertinent information (Lippincott,

2005). Overall, aesthetic appeal has been more emphasized as digital native students

have entered institutions of higher education.

Graphics and aesthetics are one of the key characteristics that make video games

so marketable to digital natives. When looking at the history of video games, it is evident

that one of the major market pushes that evolved video games was the desire to enhance a

game's realism through using advanced graphics (Malliet & de Meyer, 2005). Currently,

the graphical and aesthetic advances in video games have approached cinematic quality.

As Jenkins (2005) stated, "the aesthetics of the action movie and the video game are

hopelessly intertwined" (p. 183). As long as digital natives continue to be one of the

primary clientele in the video game market, video game companies will continue to focus

on pushing the boundaries of enhanced graphics and aesthetics in order to satisfy the ever

growing digital native demand.

A review of the literature comparing the various characteristics of digital natives and video games seems to suggest that video games serve as an engaging and interactive information medium. Video games have evolved by adapting themselves to fit the mold of what digital natives tend to enjoy. With the proportion of digital natives growing in institutions of higher education, it is reasonable to assume that video games could serve as a venue for information transfer, much like the current day lecture or textbook. However, although serious games may be an accepted learning tool by digital native standards, it still must be determined whether or not they can supply the pedagogical value that is associated with other educational tools and methods.

<center>Instructional Design of Serious Games</center>

Robert Gagné proposed a theory of instruction that would show a "rationally based relationship between instructional events, their effects on learning processes, and the learning outcomes that are produced as a result of these processes" (Gagné, 1985, p. 244). Originally published in 1965, Gagné's instructional theory, called the events of instruction, has been a cornerstone theory in the areas of instructional design and research. Rita Richey (1996) asserted that

> In essence, the 'Events' summarize much of the key research related to instruction, including factors such as motivation, perception, feedback, reinforcement, individual differences related to retention, and transfer. They provide a framework for creating those external conditions that promote learning. (p. 9)

Therefore, for a serious game to be considered a viable learning tool, it is imperative that it meet all of the events listed in Gagné's theory (Becker, 2007).

Gagné's events of instruction are "based on the information processing model of the mental events that occur when adults are presented with various stimuli" (UF Center

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for Instruction Technology and Training, 2007). Gagné determined that there were five

major categories of learning which consisted of verbal information, intellectual skills,

cognitive strategies, motor skills, and attitudes. Additionally, he suggested that each

category required different internal and external conditions in order to facilitate learning.

Using these categories, he developed nine events corresponding with cognitive processes

that were necessary to allow learning to occur (Gagné, 1985; Kearsly, 2009). Table 2

lists Gagné's nine instructional events along with their corresponding cognitive

processes.

Table 2

Gagné's Nine Events of Instruction Along With Internal Mental Processes

Instructional Event	Internal Mental Process
1. Gain Attention	1. Stimuli Activates Receptors
2. Inform Learners of Objectives	2. Creates Level of Expectation for Learning
3. Stimulate Recall of Prior Learning	3. Retrieval and Activation of Short-Term Memory
4. Present the Content	4. Selective Perception of Content
5. Provide "Learner Guidance"	5. Semantic Encoding for Storage Long-Term Memory
6. Elicit Performance (Practice)	6. Responds to Questions to Enhance Encoding and Verification
7. Provide Feedback	7. Reinforcement and Assessment of Correct Performance
8. Assess Performance	8. Retrieval and Reinforcement of Content as Final Evaluation
9. Enhance Retention and Transfer to the Job	9. Retrieval and Generalization of Learned Skill to New Situation

Source: http://www.e-learningguru.com/articles/art3_3.htm

Becker (2007) stated that "the nine events need not be distinct, separately

identifiable tasks, as often one 'event' can be combined or intertwined with another" (p.

27). He further explained this idea by suggesting that the events of gaining attention,

informing learners of the objectives and stimulating recall of prior learning can all be

found in a single predesigned action such as a pre-story to the instructional setting.

Additionally, Corry (1996) noted that in regards to Gagné's nine events of instruction,

most lessons should follow the sequence of the events of instruction, but that the order is

not absolute. Utilizing the logic stated by Becker (2007) and Corry (1996), if it can be

determined that educational games contain elements that employ each of Gagné's nine

steps of instruction, then serious games should be able to serve as effective instructional

tools.

Gaining Attention

The attention of the learner must be gained before any learning can occur. By

gaining the learner's attention, the learner is allowed to be cognitively prepared to be

receptive to the content about to be presented (Gagné, 1985). Gagné stated that "the

attention of students, in the sense of alertness for reception of stimuli, is gained by

introducing rapid stimulus change" (p. 246). He further explains that this rapid stimulus

change can be achieved through visual stimuli. Kruse (n.d.) also suggests that a good

way to capture a learner's attention is "to start each lesson with a thought-provoking

question or interesting face" (p. 1).

Since a video game has to compel a potential player, it is imperative for the game

to gain attention. Therefore, games have multiple methods of gaining the attention of

their users. Similar to movies, games use enhanced graphics, enhanced aesthetics, and

engaging storylines to help gain a player's attention. Many video games have highly

detailed video clips and media trailers that play during the game's initial loading

sequence. Just as in a movie, this video introduction allows the player to become

immediately engaged in the virtual world and virtual story that is being acted out in the video game. (Becker, 2007).

An additional method of gaining attention that is used in video games is the use of a game demo prior to starting the official game. This demo mode is "what one sees when the game appears to be playing by itself – it shows elements of the game play and is intended to entice players to choose this game over others" (Becker, 2007, p. 27). Whether you use introduction videos or a demo mode, game developers have realized the importance of gaining a player's attention. Therefore, most games have built in mechanisms to help them meet Gagné's first event of instruction.

Inform Learners of Objectives

The second event of instruction is to inform the learners of the learning objectives. "When learners comprehend the objective of instruction, they will acquire an expectancy that normally persists throughout the time learning is taking place and that will be confirmed by the feedback given when learning is complete" (Gagné, 1985, p. 246-247). Kruse (n.d.) emphasized this point by stating that it is important to clearly list the objectives to the learners early in the lesson because this "initiates the internal process of expectancy and helps motivate the learner to complete the lesson" (p. 1).

The ultimate objective of a game is to meet the victory conditions in order to win. Becker (2007) stated that "given the culture that already exists around video games, information about the objectives of games and approaches for play are becoming part of what could be described as basic game literacy" (p. 28). In most games, the objectives are either explained through game instructions or through the storyline. If a game is based off of a series or based on other media such as a movie, it is common for the

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objectives to follow the predetermined storyline that has already been established. For example, a game based on the Lord of the Rings trilogy will generally have an objective and win condition associated with destroying the Ring of Power. Therefore, games incorporate learning objectives in their win conditions or storylines, ultimately accomplishing Gagné's event of informing learners of the objectives.

Stimulate Recall of Prior Learning

Once the learner has been informed of the objectives, Gagné suggested that the next event of instruction is to stimulate the recall of prior learning in the individual. As Gagné and Briggs (1979) explained, "learning a rule about *mass* (Newton's Law) involves a combination of the ideas of *acceleration* and *force*, as well as the idea of multiplying" (p. 159). Ultimately, "it is easier for learners to encode and store information in long-term memory when there are links to personal experience and knowledge" (Kruse, n.d., p. 1).

Games can stimulate prior learning in a number of ways. Many video games implement a series of tutorials to teach the player the mechanics and rules of the game. These lessons must be recalled and utilized throughout the game in order to successfully reach the end-game objectives and win conditions. Additionally, video games utilize leveling which requires the players to use information learned in previous levels in order to accomplish later, more difficult levels. Becker (2007) explained that "even when it is not explicitly noted in the game, by now virtually all game players are aware of the concept of levels, where each level requires players to build on knowledge and skill acquired in the previous level" (p. 28). A final method of information recall deals with a repetition cycle implemented in a number of games. If you fail to complete a given level

in a game, you will most likely be required to repeat that level until its successful

completion. While reattempting the level, the player will once again encounter the

situation that you were unable to successfully complete. By recalling the methods that

ultimately failed, the player can implement a new, adapted strategy in order to overcome

the objective.

The serious game platform has a number of built in mechanisms that allow for

recall of prior knowledge. Although some of these mechanisms only require basic recall

of information, prior knowledge is required to be successful.

Presenting the Content

In Gagné's fourth event of instruction, the instructional material is presented to

the learner. Although this task seems relatively easy, it is important to note certain

guidelines in order to make the learning experience as efficient as possible. Kruse (n.d.)

suggested that "content should be chunked and organized meaningfully, and typically is

explained and the demonstrated" (p. 1). Gagné and Briggs (1979) stated that the

information can be more meaningful to the learner when incorporating elements that use

selective perception. Examples of these elements include italic texts, underlining, and

physical arrangements of the presentation that emphasize certain areas.

Information is displayed in games and simulations through a variety of different

means. Some of these games use video clips and audio narration to display content to a

player. Other scenarios use text to help visualize characters talking or tables with

numbers to identify character strengths and weaknesses. Ultimately, games display

enormous amounts of data in a variety of different ways so that a player can select the

most appropriate method of gathering information and making a decision and avoid

becoming frustrated and giving up (Becker, 2007). This is beneficial to the player because to appeal to different learning styles, a mix of various forms of media should be used if possible, including text, graphics, audio narration, and video (Kruse, n.d.). Therefore, Gagné's fourth event of instruction is fulfilled since games have the ability to effectively present content and information to the learner in a variety of different ways.

Provide "Learning Guidance"

Providing guidance to the learner is the act of supplying a suggested line of thought and giving hints that will lead towards an end objective and new knowledge (Gagné & Briggs, 1979). Kruse (n.d.) suggested that "to help learners encode information for long-term storage, additional guidance should be provided along with the presentation of new content" (p. 1). Gagné (1985) and Kruse (n.d.) agreed that there are multiple ways to provide guidance to the learner. Some of the methods suggested include case studies, graphical representations, mnemonics, and analogies. Gagné also suggested that the instructor should "make the stimulus as meaningful as possible" (p. 252). He expanded this thought by stating that "in general, meaningfulness may be enhanced by (1) using concrete examples of abstract terms and concepts, and (2) elaborating each idea by relating it to others already in memory" (p. 252).

Serious games also incorporate the concept of guidance. Multiple mechanisms are used to provide guidance in games depending on the game scenario and the concept being taught. "Verbal or written hints, items that glow briefly as they come into view, and [non-player characters] that tell you something or offer help are all ways in which guidance can be provided" (Becker, 2007, p. 29). More sophisticated video games are forming communities of players that help to provide guidance to new players. In the

video game *Demon's Souls (2009)*, players are guided by watching other players'

failures. As Vanord (2009) explained in his review of the game,

> These ghosts are only one of several ways other players will be assisting you on
> your journey. You'll notice plenty of bloodstains coating the ground; by activating
> them, you'll witness an instant replay of another player's final few seconds before
> the unfortunate victim succumbed to death. These bloodstains may warn you of
> an upcoming drop into nothingness, a particularly difficult enemy encounter, or a
> deadly trap waiting to be sprung. (p. 2)

As time progresses, games will discover more and more unique and interactive ways to

help guide the learner towards their objectives.

Video games use automated and personal forms of guidance that help the learner

with semantic coding. These mechanisms help encode information. Therefore, video

games successfully meet the criteria established in Gagné's fifth event of instruction.

Elicit Performance

The previously detailed of Gagné's events of instruction were designed to assure

that learning takes hold once it has occurred (Gagné, 1985). According to Gagné and

Briggs (1979), "having had sufficient learning guidance, the learners will now be carried

to the point where the actual internal 'combining' event of learning takes place" (p. 162).

Essentially, the learner has seen how to achieve the required objective and now it is their

turn to accomplish it. Kruse (n.d.) explained that "eliciting performance provides an

opportunity for learners to confirm their correct understanding" (p. 1).

Eliciting performance is the essence of any game. In order to play the game, the

player must interact with the system. Becker (2007) emphasized this thought by

explaining that eliciting performance is "an essential component of interactivity – without

this, there really is no game" (p. 29). The fact that the essence of a game is for the user to

interact with the developed system confirms that games meet the guidelines described by Gagné.

Provide Feedback

Providing feedback is important for the learner to determine whether or not they have performed required tasks at a reasonable level of satisfaction. As Gagné (1985) stated, "following the performance which shows that learning has occurred, there must be a communication to the learner about the correctness and the degree of correctness of the performance" (p. 254). Kruse (n.d.) further explained that "as learners practice new behavior it is important to provide specific and immediate feedback of their performance" (p. 1). In certain situations this feedback is obvious and essentially automated, such as in the case of determining whether or not a capital city is correctly associated with a country. However, there are situations that require a detailed amount of feedback, such as determining whether or not the quality of an essay is acceptable. In either situation, it is important to inform the learner of his or her progress throughout the learning exercise because giving effective feedback is important for ensuring that the student reaches competency (Nicholson, Cook, Naish, & Boursicot, 2008).

Games also have feedback mechanisms to inform players whether or not they are successfully proceeding towards completing the objectives. Some mechanisms of feedback include scores, heads-up displays, and verbal feedback (Becker, 2007). Scores are an easily understandable, automated form of feedback. As the player successfully works towards their objectives, the score will increase. On the other hand, if a player is not performing the tasks correctly, their score will remain stagnant or decrease. Heads-up displays and feedback are more detailed and intricate forms of feedback (Becker,

2007). Heads-up displays can tell players of their status in games as well as the status of other characters and items or equipment each may have. For example, as the numbers and colors change on a heads-up display, more and more detailed feedback is being delivered to the player.

Feedback is essential regardless of whether it is simple or detailed feedback. Just as the simple gesture of a nod can inform a student of a correct response in a classroom, the visualization of an increasing score as a student selects the correct response can also serve as a simple feedback response. These feedback mechanisms show that video games meet the criteria established in Gagné's seventh event of instruction.

Assess Performance

Once an instructional module has been completed, students should be given a final assessment as a verification that learning has occurred. This assessment should be completed without additional coaching, feedback, or hints (Kruse, n.d.). Gagné (1985) stated that "since performance is typically a single act of the learner, it indicates only some reasonable probability that the capability has been stored in a reliable (i.e., stable) manner" (p. 255). Therefore, some repetition of the assessing performance may be necessary to increase the validity and reliability of the assessment. Regardless of one iteration or multiple forms of assessment are used, it remains clear that a final, unaided assessment need to be given to the student in order for the instructor to determine whether or not learning has occurred.

Games generally have multiple small assessments built into them. These small assessments can be in the form of completing a given level or completing a series of tasks to drastically increase a score. Ultimately, all games and simulations have one major

assessment and that is the determination of whether or not the player has won the

competition. As Becker (2007) stated,

> Since virtually all games are contests on some level, achieving a favorable
> assessment is what the game is about. The journey is important, to be sure, but
> even in a game like *Dance, Dance Revolution* where there are no opponents to
> fight, no treasure to find, and no puzzle to solve, a running "score" of how closely
> the players' moves approximate perfection is essential. (p. 29)

Since winning the game or successfully completing the scenario is an assessment within

itself, games successfully meet the criteria described in Gagné's eighth event of

instruction.

Enhance Retention

Retaining knowledge and developing the ability to use that knowledge in similar

situations is the goal of learning. Kruse (n.d.) suggested that "repetition of learned

concepts is a tried and true means of aiding retention, although often disliked by

students" (p. 1). Gagné (1985) emphasized this idea when he stated that "increased

amounts of practice constitute a fairly dependable factor for affecting amount of

retention" (p. 255). Although repetition can be beneficial in terms of retention, it must be

implemented in a way that maintains student attention.

The problem surrounding knowledge transferability deals with the cues that

initialize a given situation. Most scenarios occur due to different reasons and those

different reasons may or may not stimulate recall of prior learned knowledge. Gagné and

Briggs (1979) suggested that in order to enhance transferability of knowledge, the best

technique to implement is increased repetition using a variety of new tasks. By changing

the practice scenarios, learners have a higher probability of being able to use the learner

knowledge in a greater multitude of situations.

Games also use techniques to enhance retention and transferability of knowledge. In many video games, the failure to successfully complete a level requires that the player re-attempt that level until they successfully meet the objectives. Additionally, many games allow customizability so that a player may re-attempt a successfully completed level in order to better their score or gain more advantages for future levels. Finally, Becker (2007) states that "on a larger scale, skills and strategies learned in one game are often applicable to sequels, other games, and even entire genres" (p. 29). Therefore, video games implement techniques to enhance retention and transferability of knowledge and, consequently, satisfy Gagné's ninth event of instruction.

When reviewing Gagné's nine events of instruction, it seems that serious games meet the needed criteria to be considered an instructional tool. By using Gagné's events and the characteristics of digital native students, serious games theoretically have the potential to serve as an effective instructional tool with today's students. However, a review of empirical research surrounding the area of serious games is needed to determine the validity of these theoretical claims.

<div align="center">Empirical Research on Serious Games</div>

There have been a number of studies published discussing the feasibility and possibilities of using serious games in the classroom (Chang, Gutl, Kopeinik, & Williams, 2009; Chuang & Chen, 2009; Harder, 2009; Hew & Cheung, 2010; Kee et al., 2009; Schrader & McCreery, 2008; Wang, Song, Xia, &Yan, 2009). Hew and Cheung (2010) conducted a review of the literature regarding virtual worlds and found 470 papers in a two month span. These articles were found using four educational databases followed by a snowballing effect of acceptable articles. Therefore, even a search limited

to four databases and focused on a specialized area of serious games revealed a large quantity of papers.

Although papers on the subject are easy to find, it is more difficult to find articles and papers offering empirical data resulting from studies using these tools. For example, although Hew and Cheung (2010) identified 470 papers while reviewing the literature on virtual worlds, "of these 470 papers, 455 were discarded because they were opinion papers, conceptual papers, non-empirical descriptions of programme implementations, literature reviews or non-K-12 and higher education related" (p. 35). A second review of literature conducted by Harder (2009) regarding empirical data resulting from studies conducted on the use of serious games in health science fields yielded only 23 articles containing empirical data out of a potential of 61 possible articles.

Although empirical studies on the topic seem rare compared to theoretical and qualitative studies, those found and reviewed seem to focus on three generic research themes. In the literature review performed by Hew and Cheung (2010), they suggest that the three generic research topics are the participants' affective domain, participants' learning outcomes, and participants' social interaction. Although Hew and Cheung's literature review was specified to the area of virtual worlds, an examination of other empirical studies researching areas of serious games (Chang, Gutl, Kopeinik, & Williams, 2009; Chuang & Chen, 2009; Kee et al., 2009; Schrader & McCreery, 2008; Wang, Song, Xia, & Yan, 2009) have primarily focused on similar research topics. With these three themes consistently appearing in the research, each are described in greater detail in the following review.

Affective Domain

Hew and Cheung (2010) define the affective domain as participant's attitudes and satisfaction when interacting with a game or simulation. These attitudes include areas such as likes, dislikes, perceived benefits, and perceived limitations regarding the overall learning experience. Most of the data derived from these studies were gathered using descriptive research methods such as observation, student surveys, and review of student logs and journals.

Wang et al. (2009) conducted a study to determine student perspective's on using Second Life applications as a method to teach English as a second language. Students participating in the study reported that they enjoyed utilizing the virtual world as a learning platform. One student commented on the virtual world's interface stating "I feel that the whole interface is interesting and fresh. We can go to different locations to talk. On the whole, it's very good" (p. 9). When discussing the overall feel of using the virtual world as a learning media, another student commented:

> It's something like a virtual game since people can change images and doing actions in it. However, it isn't just a game but a medium of learning with the combination of a learning element and game element…People can learn with fun and enjoy pleasure from learning, which improves our learning interests greatly. (p. 10)

The study concluded that "the EFL Program participants perceived Second Life as a useful and interesting language learning platform. In addition, the EFL Program participants perceived the EFL Program in Second Life to be interesting and successful" (p. 12).

Pannese and Carlesi (2007) conducted a study on the effectiveness of serious games in both a business and educational setting. The results of the survey conducted at

the end of the study showed that over 50% of both the university and business

participants found the game effective. "Game effectiveness is high or very high

according to 89% of the employees, while the percentage decreases to 68% according to

the students' opinion" (p. 448). Additionally the study reported that "Ninety-five per

cent of employees evaluate the degree of pleasure of playing as high or very high, while

according to students' opinion, the percentage slightly decreases to 78%" (p. 448).

Lastly, the study indicated that the participants remained engaged while undertaking the

activity. "More than 80% of employees (80% of students) feel involved while interacting

with the proposed game, which is preferred to other 'traditional' training methodologies"

(p. 449). Ultimately, it was concluded that the use of a serious game in the training of

employees or in the teaching of students is beneficial when combined with other

instructional methods.

In both of these studies, it was determined that serious games had a positive

experience on the participant's affective domains. However, Hew and Chueng (2010)

suggested that a few studies in their review of the literature showed that some participants

were overwhelmed by the use of educational games. Possible technical difficulties,

unfamiliarity with using the media, and lack of face-to-face assistance were some of the

suggestions as to why some users may not have a satisfactory experience. Additionally,

it should be pointed out that these studies were mostly self-reported by the participants

and that the self-reported data may not be reliable due to various validity problems.

Learning Outcomes

In order to observe learning outcomes, a study looks at whether or not actual

knowledge was obtained at the conclusion of using a serious game. According to Hew

and Chueng (2010), learning outcomes can be studied either descriptively or experimentally. In their survey of literature, a majority of the studies that determined learning outcomes did so descriptively. The data was gathered using self-reported surveys with Likert scale questions and open ended questions.

Chuang and Chen (2009) conducted a study to determine whether or not the use of video games increased learning in children when compared to basic computer aided instruction. Their study consisted of 108 third grade students. The students took a test after they had completed the serious game and the data was compiled from these scores. Chuang and Chen determined that the educational game enhanced student learning beyond the level of the general computer aided instruction. They stated:

> The statistical results clearly show a significant difference between computer-assisted instruction and computer-based video game playing in students' learning achievement. Based on this finding, playing computer-based video games was determined to be more effective in facilitating third-graders' average learning outcome than text-based computer-assisted instruction. (p. 7)

Although Chuang and Chen noted that the third grade students involved with the study were required to be computer literate, they mentioned that they were confident that the results of the study remained generalizable.

A study conducted by Richard Blunt (2009) sought to determine a Return on Learning (ROL) when using educational games. Blunt defines ROL as "metrics that show improvements in grades, increased student throughput, decreased costs of education or training, or faster learning" (p. 1). The study was conducted on three university level business courses. The courses consisted of first year business students, third year economics students and third year business management students. The results of the study showed that exam scores and grade distribution in each of the courses increased

when the educational games were used by the students. The data was further analyzed

and showed that exam scores and grade distribution increased regardless of gender and

ethnicity when the educational games were used. The only distribution that showed a

decrease in exam scores was the age bracket 41-50 years of age. Whereas digital natives

were shown to be accepting and embracing of educational games, digital immigrants

were less likely to embrace the tool. Since the age bracket of 41-50 years of age is

classified in the digital immigrant category, this could explain the drop in test scores.

In these studies, experimental data was used to determine whether or not a serious

game can be effective in developing desired learning outcomes. Although the results of

these studies are promising, it must be cautioned that educational games will not always

prove beneficial. As seen in Blunt's (2009) study, the age bracket of 41-50 did not

benefit from the use of serious games. However, "at least in some circumstances, the

application of serious games significantly increases learning" (Blunt, 2009, p. 5).

Social Interaction

The third topic studied in a large portion of the research articles dealt with social

interactions resulting from the use of a serious game. Hew and Chueng (2010) describe

social interaction as interaction between participants while using the application. In

addition to the definition provided by Hew and Chueng, the studies that demonstrate

social interaction resulting from the use of a serious game or occurring after the use of a

serious game have also been added to this category. Examples of this criterion include in

class discussions and critical analysis revolving around a topic or action conducted in the

game. It should be noted that a majority of the data gathered in the studies related to

social interaction was gathered using descriptive methods such as self-reporting, review of online journals, and observation.

A study conducted in 2009 sought to empirically determine the effect of social interaction when applied to educational games. The study involved 41 students from a university in South Korea. Some of the students were assigned to use a game that incorporated networked interactivity, or interaction "made possible by real-time network connection among students or between students and teachers" (Jeong, Park, Ryu, & Lee, 2009, p. 4). The control group was assigned to play a similar game that did not incorporate networked interactivity. Each of the groups was given a similar test following the completion of the game in order to determine the amount of social interaction and learning that occurred. The study determined that "social interactions (i.e., competition) among students are important in enhancing perceptions toward learning and test performance" (Jeong et al., 2009, p. 24). Additionally, the researchers stated that "although the non-interactive game condition employed a similar game interface and instant feedback to students' performance, no social interaction and competition between students resulted in almost the same outcomes with the tradional lecture-based learning method" (p. 25). Therefore, according to Jeong et al. (2009), social interaction while proceeding through a serious game is beneficial.

In Kardynal's (2009) thesis study on serious games, he also took note of the amount of collaboration between participants involved in the study. He reported that "students enjoyed openly discussing and collaborating with their peers during gaming sessions" (p. 69). He also found that collaboration would usually be sparked by a problem or comment originating from the game play and that once a discussion started, it

quickly grew and expanded. He also discussed how the instructors were easily able to manipulate the amount of student collaboration and interaction. Instructors commonly used class and group discussions and written assignments to enhance the overall effect and amount of student collaboration.

Another study, conducted by Mansour and El-Said (2009), attempted to determine the impact on student to student interaction when a massively multiplayer online application was introduced into a classroom environment. There study revealed that the use of a massively multiplayer online application did increase student relationships with their peers. They stated that a very small number of students reported that a game had a negative impact on the relationships with their classmates. Additionally, they stated that "the results revealed that playing the game encouraged students to extend their relationships with their classmates beyond the classroom boundaries and to form social relationships with their classmates" (p. 235). Therefore, according to Mansour and El-Said (2009), the conversation and deep discussion that is created with the use of a serious game or simulation does increase the collaboration among students.

Thus far, empirical research has revealed promising results when students use serious games in education. However, the small amount of data gathered from this research makes generalization or policy change hard to justify. Therefore, it seems prudent that more empirical data be collected to help determine the validity of serious games as instructional tools. This study will attempt to provide some of that empirical data.

Summary

Reviewing a wide variety of scholarly articles related to the use of serious games as pedagogical tools has shown the potential benefits that serious games can offer. A majority of undergraduate students are digital natives and are demanding new, innovative, and technological solutions to increase the efficiency of their learning. Many of the characteristics that define this student population also suggest that the use of serious games would be accepted and beneficial. The engaging, interactive, social, and technological possibilities of this tool have the potential to address what today's students want (Prensky, 2005; Prensky, 2006; Gee, 2007).

Additionally, from an educational theory perspective, properly conceived uses of games in the classroom can enhance instructional material that is already being taught. As discussed earlier, games can be built incorporating Gagné's nine events of instruction. Therefore, instructional material can either be used in a game or a game can be used in instructional material.

Empirical studies have been conducted in an attempt to demonstrate the effects of serious games on learning. These theories centered around one of the three following research themes: effects on affective domain, effects on learning outcomes, and effects on social interaction and collaboration. Although a majority of the studies were self reported and stated that the generalizability of the study was limited, the overall results of the studies were positive. In all three research areas, the use of educational games or simulations in teaching and learning benefited the participants in the studies.

Most of the empirical studies derived their data from either surveying the thoughts of a variety of students who used a serious game or reviewing the test results of students

that used a serious game and students in a control group that did not use one. The studies

did not refer to the method of instruction given to the control group. Without this

information and the vagueness of the term "traditional learning methods", it seems

warranted that a study should be conducted to compare the learning outcomes of

equivalent instructional material using different, specified modes of instructional

delivery. One of these modes of delivery should be a serious game. This would help in

determining whether or not a serious game can help a student learn as efficiently as

traditional learning techniques. This study was designed to address that concern.

Chapter 3

Methods

The purpose of this study was to determine the effectiveness of serious games as an instructional technique. This study compared the differences in student scores following an instructional session. Specific comparisons will be made between the instructional techniques of audio lecture, textual reading, and serious games. Lastly, demographic information will be compared to determine whether certain students perform better under each instructional technique.

Research Questions

1. What are the differences in student test performance upon the completion of one of the following instructional techniques: audio lecture, text reading, or serious games?

2. What is the relationship, if any, among demographic variables (age, gender, game-play frequency, etc) and student-test performance among each of the instructional techniques?

This chapter describes the methods used to answer the research questions. It specifically describes the research design, population, instrument, data collection procedures and the data analysis.

Methods

In order to determine the amount of knowledge obtained by each participant during the instructional period, the decision to implement a pre-test and post-test element

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to the design was made. The pre-test served as an evaluation of each participant's prior knowledge pertaining to the subject material. The instructional period followed immediately after the pre-test. A post-test was administered directly following the instructional period. A comparison of the pre-test and post-test scores allowed for determining the amount of knowledge obtained by each instructional method.

Once the testing procedure was determined, appropriate instructional tools and subject material needed to be determined. An instructional unit consisting of content in the area of crop domestication was selected to serve as the subject matter for testing. The subject of crop domestication was selected because it is general enough to be taught in a relatively short period of time, yet most students would not have prior knowledge of the subject. A pre-test, post-test, serious game, and instructional text were created by a tenured, full professor with expertise in the area of agronomy, soils, and plant genetics. The faculty member developed the materials covering the topic of crop domestication, which he had taught for multiple semesters.

With the instrument and data gathering procedures developed, the question of population and sample size needed to be answered. After trends in the literature review suggested millennial students would be one of the prime beneficiaries of serious games, the population for study is undergraduate college students, with a significant majority being digital natives and millennial students. Data was collected in classes at a large, public research university in the southeastern United States. Six undergraduate classes were randomly selected from three different colleges within the university. Each of the three instructional techniques used in the study were given to two of the classes.

Students were registered in the classes prior to the start of the study. Therefore, although random selection was applied to choose the classes used in the study, random assignment of the study participants was not possible. Therefore, a quasi-experimental research design was warranted. Johnson and Christensen (2000) define quasi-experimental research design as "an experimental research design that does not provide for full control of potential confounding variables" (p. 255). They go on to further state that "in most instances, the primary reason that full control is not achieved is because participants cannot be randomly assigned to groups" (p. 255). Best and Kahn (2006) compliment this description, stating that "these designs provide control of when and to whom the measurement is applied, but *because random assignment to experimental and control treatments has not been applied,* the equivalence of groups is not assured" (p. 183). Creswell (2005) also notes that since quasi-experimental designs do not incorporate random assignment, more threats to internal validity are introduced when compared to a true experimental design. Although the possibility of using this type of design increased the chances of threats to internal validity, Creswell also describes situations in which quasi-experimental designs are necessitated (p. 298).

The study utilized a pre-test and post-test assessment; therefore, a repeated-measures data analysis was warranted. However, the study also grouped the participants into various categories. Therefore, a mixed design ANOVA was used to determine differences in student performance using each of the instructional techniques as groups. Ross and Shannon (2008) describe a mixed design ANOVA as "an approach that can accommodate your interest to compare unrelated and related group means together" (p. 127). They continue by explaining "we sometimes describe the mixed design as a

repeated-measures ANOVA employing a *within-subjects factor* (the repeated-measures component) and a *between-subjects factor* (the group-difference component)" (p. 127). Since the study groups the repeated-measures test into the category of instructional technique, a mixed design is the most appropriate to determine the differences in each instructional type. Additional mixed design ANOVA analyses were conducted to determine differences in demographic data as it applied to various instructional techniques.

<div align="center">Sample</div>

The population of this study is undergraduate college students. Due to cost and time constraints, a sample population was used in the study. The sample population consisted of undergraduate college students from a public four-year research university located in the southeastern region of the United States. Classes with 25 or more enrolled students were identified to participate in the study. Also, no classes from the any colleges related to agriculture or crop domestication were sought to participate to protect against validity threats due to familiarity of the subject matter. From the classes identified as having 25 or more students based on class enrollment, a convenience sample of eight classes was selected to participate. Four of the classes chosen to participate in the study were selected because they were conducted in a computer lab.

Out of the eight classes selected to participate in the study, two of the classes were in the College of Business, four classes were in the College of Education, and two in the College of Science and Math. The total number of students enrolled in the classes selected for the study was 541. The students registered in the selected classes were assigned to have the various instructional techniques administered at the following

number of participants: Audio Lecture: 178, Text Reading: 238, Serious Game: 124. Due

to a number of students not attending class because of flexible attendance policies in the

classes used for the Audio Lecture and Text Reading, the total number of participants

using each of the instructional techniques was approximately the same.

Participation by the students was voluntary and students declining to participate in

the study were asked not to fill out the instrument, although they could still participate in

the accompanying raffle incentive. Any students who entered the classroom after the

study began were asked to remain outside until the completion of the study.

Instrumentation

Three different items made up the instrumentation for this study: a pre-test, a

post-test, and instructional material. All three items were developed by a tenured faculty

member with expertise in the subject matter area of crop domestication. In addition to

the pre-test and post-test, the instructional material developed by the faculty member

included a written form of instructional text (see Appendix A). This text was translated

verbatim into an audio file. Finally, a serious game was developed based on the content

in this text (see Appendix B). All three versions of the instructional material were sent,

along with the pre-test and post-test, to a panel of tenured and tenure-track faculty with

expertise in agriculture for review. The panel verified that the information presented was

accurate and that the pre-test and post-test accurately reflected the content being

presented in the instructional material (see Appendix C-E).

The pre-test contained 18 matching questions. Following verification by the

expert panel, three demographic questions were added to the end of the pre-test. These

questions requested that the participants select their gender, ethnicity, and general

frequency of game play.   Ethnicity, a categorical variable, had seven possible responses: Native American, White, not of Hispanic Origin, Hispanic, Black, not of Hispanic origin, Asian / Pacific Islander, Multi-racial, and Other. General frequency of game play, also a categorical variable, had six possible responses: Multiple Times a Day, Once a Day, Once a Week, Once a Month, Once Every Three Months, and Fewer Than Once Every Three Months.

In accordance with a repeated-measures design, the post-test contained the same 18 matching questions. However, in an attempt to minimize the impact of test-wiseness, defined as the use of strategies to increase the chances of selecting the correct answer choices on a given test (Farr, Pritchard, & Smitten, 1990; Millman, Bishop, & Ebel, 1965; Sarnacki, 1979; Reich, 2009; Rogers & Bateson, 1991), the 18 questions were rearranged and presented to the participant in a different order. Also, as was the case with the pre-test, three additional demographic questions were added to the end of the post-test. These questions requested that the participant provide the number of unique games played over the past year, their major, and their preferred learning style. Both the number of unique games played over the past year and major questions were open-ended questions. The answers provided in the major field were used to determine the college at the university that each participant was enrolled in. Finally, the preferred learning style question was created as a categorical variable based on the VARK learning styles model (Roopnarine, 2008). The question allowed the following responses: Visual (pictures, visual aids, diagrams, etc.), Auditory (lecture, discussions, tapes, etc.), Reading / Written, and Kinesthetic / Tactile (active exploration, science projects, experiments, etc.). Although most learning styles inventories are comprised of multiple questions and tests

to inform a user of their preferred learning style, due to realistic constraints for class time in the data collection process, it was determined that participants could self-report their preferred learning style. Additionally, due to a large number of participants selecting multiple learning styles as their preferred learning style, the researcher decided to treat each learning style as a dichotomous selection for analysis purposes.

<p style="text-align:center">Validity and Reliability</p>

The instruments used in this study were not based on a pre-existing set of instruments; hence, concerns of validity and reliability needed to be addressed.

Validity is the "extent to which our data-collection instruments, or processes, measure what they are supposed to measure" (Ross & Shannon, 2008, p. 219). In order to antiquate concerns of validity, a panel of experts, which included multiple tenured or tenure-track faculty members with expertise in the area of agriculture, reviewed all of the instruments related to the study. The panel members were asked to review items for appropriateness of content coverage and equality of the content covered by each of the three instructional methods. Based on the panel's recommendations, one answer was corrected on both the pre-test and post-test and a clarification in the text and audio instructional methods was made to align those methods more closely to the serious game. Items were then sent to panel members a second time, resulting in 100% agreement that items appropriately and fully covered the content.

Reliability is defined as the "extent to which [the data-collection instruments] yield consistent results with minimal error" (Ross & Shannon, 2008, p. 219). A statistical check of internal consistency was performed on the entire data set using Cronbach's

alpha. This reliability analysis yielded a good coefficient of .81, indicating a strong internal consistency (George & Mallery, 2003).

Data Collection

Prior to collecting data for this study, the researcher obtained permission from the Institutional Review Board (IRB) at Auburn University (see Appendix F). Additionally, the researcher gained permission from the instructors of the participating classes so that time could be allotted for data collection. Each of the instructors allotted one class session for approximately 20 minutes at the beginning of the selected classes to collect data.

Students' participation was voluntary with his or her informed consent. Refusal to participate involved no penalty, there were no risks, and if at any time a person wished to stop participating, he or she was free to do so. Any participants that were 18 years old or younger were allowed to participate in the study; however, their data was not coded or entered into the analysis unless parental consent documents were completed and returned to the researcher by the end of the semester in which the data was gathered. All responses were kept confidential and anonymous.

In the first five minutes of the allotted collection period, instrument packets were passed out to the participants. The packets consisted of the following documents in the following order: Participant Information Form with IRB Stamp, Pre-Test Instrument, Blank Sheet of Paper, Instructional Text (only for the sections being instructed using Instructional Text), Post-Test Instrument, and Raffle Ticket. Each of the pre-test and post-test instruments were pre-coded so that the two documents would be associated with each other in case the packet became separated. While the packets were being passed

out, the researcher informed the participants about the study. Additionally, students who were 18 years old or younger were notified to meet with the researcher directly following the collection of the instruments so that they could be given a parental consent document and have their instruments coded to insure that they were not used unless the consent documents were returned within the specified time period. No instruments completed by minors were compiled in the data analysis unless a parental consent document was returned. After the distribution of the instrument packets, participants were given four minutes to complete the pre-test. This was directly followed by a four minute instructional period. Lastly, the participants were given four minutes to complete the post-test.

As each of the participants took the pre-test, they were instructed to go no further than the first blank white page they came upon. For the cohort using the instructional text, during the instructional period, they were instructed to read the text page following the blank white page. The participants were told that they could take notes on the page as they normally would when in class. They were instructed not to proceed past the next blank white page in order to prevent them from prematurely viewing the post-test. The cohort was given four minutes to read the instructional text as many times as they wanted to. Before beginning the post-test, the participants were instructed not to use their notes, the pre-test, or any other materials on the post-test.

Students receiving the audio presentation were also instructed to stop at the blank white page while proceeding through the pre-test. During the instructional period, the researcher played the audio version of the instructional text over the classroom computer's speakers. The audio file lasted approximately 2 minutes and 10 seconds.

Therefore, the audio clip was played twice for the participants. The participants were directed to use the blank white page as a scratch sheet of paper to take notes as they normally would in a class. Before beginning the post-test, the participants were instructed not to use their notes, the pre-test, or any other materials on the post-test.

Data for the students receiving the serious game instructional technique were collected using a computer lab so that every participant had access to the Internet and a computer. Participants were instructed to not proceed past the blank white page when completing the pre-test. Upon finishing the pre-test, the participants were given an Internet URL linking to the serious game. Participants accessed the game and had four minutes to proceed through the game as many times as they desired. They were told to use the blank white page in the instrument packet as a scratch sheet of paper to take notes as they normally would in a class. Before beginning the post-test, participants were instructed to close their Web browsers and not to use their notes, the pre-test, or any other materials on the post-test.

Overall, a total of 340 students participated in the study. Of those participants, 26 were omitted from the analysis due to a failure to return a completed parental consent form.

<center>Data Analysis</center>

The methodological approach to data analysis used in this study is quantitative. After collecting all of the instruments, the researcher compiled the total number of questions answered correctly for each participant's survey. The pre-test and post-test scores were entered into a statistical software package (SPSS v. 16) along with each participant's demographic data. The first analysis involved computing the descriptive

statistics for each variable, such as frequencies, means, standard deviations, and measures of skewness.

After analyzing the descriptive data, a series of repeated measures ANOVAs were performed to determine differences within the independent variables and the dependent variables. The level of significance for each ANOVA was set at .05. Conclusions based on the findings are reported in the next chapter.

<center>Summary</center>

This chapter details the methods that were used throughout the study. The chapter reviewed epistemological concerns and reasons why a quasi-experimental design was chosen. An examination of the criteria surrounding the sample population, a description of the instrumentation and data collection procedures, and an accounting of the data analyses used in the study were discussed. The next chapter presents the findings based on the preceding methods.

Chapter 4

Findings

The purpose of this study was to determine the effectiveness of serious games as an instructional technique. This study compared the differences in student scores following an instructional session. Findings from comparisons between the instructional techniques of audio lecture, textual reading, and serious games will be reported. Demographic information will be used to report findings about whether certain students perform better under each instructional technique.

Research Questions

1. What are the differences in student test performance upon the completion of one of the following instructional techniques: audio lecture, text reading, or serious games?

2. What is the relationship, if any, among demographic variables (age, gender, game-play frequency, etc) and student-test performance among each of the instructional techniques?

Sample

The original sample for this study consisted of 340 undergraduate students, representative of undergraduates at a public, four year research university located in the southeastern United States. Of the 340 participants, 27 were under the age of consent and, thus, required parental consent to have their surveys analyzed. Of the 27 under age

participants, only one participant returned a completed parental consent document.

Therefore, the total number of participants used in the study was N = 314.

The pre-test and post-test questions were reviewed and graded. Any answers that were left blank were counted as incorrect answers. On both the pre-test and the post-test, a total of 18 correct answers were possible. The total number of correct answers was the number used to represent the pre-test score and the post-test score.

<center>Data Independence Check</center>

A number of chi square tests were performed to determine the level of association on various categorical variables used in the study. "A chi square (X^2) statistic is used to investigate whether distributions of categorical variables differ from one another" (Ryan, n.d., p. 1). Upon running the analyses, it was determined that two different groupings of variables had significant interaction. Therefore, these two groups are associated and not independent of one another (Archambault, 2000). The first group of variables was the grouping of the variable instructional method and the variable of gender ($x^2_{(1, N=314)}$ = 67.77, $p < .001$). When examining the descriptive statistics of this group, it was found that the instructional technique of serious game consisted of 86.8% female and the instructional technique of audio lecture consisted of 65.6% male.

The second grouping was the variable instructional technique and academic discipline ($x^2_{(1, N=312)}$ = .019, $p < .001$). In this group, it was found that the instructional technique of serious game consisted of 99.1% social science participants, 0.9% of professional school participants, and 0% hard science participants. Two participants did not disclose the information needed to place them into an academic discipline and was thus excluded from this part of the analysis.

Extent of Knowledge Gained by Various Instructional Techniques

Research Question One

What are the differences in student test performance upon the completion of one
of the following instructional techniques: audio lecture, text reading, or serious game?

For this question, all 314 participants in the study attempted both the pre-test and
the post-test. The total number of students and participating in each instructional
technique was roughly equivalent (see Table 3).

Table 3

Number of Participants in Each Instructional Method

Instructional Method	N	%
Text	95	30
Audio	113	36
Serious Game	106	34
Total	314	100

A *t*-Test was conducted on each of the instructional techniques to determine
whether or not knowledge had been acquired by the individual techniques. Each
technique appeared to impact the amount of knowledge gained by the student (see Table
4). For each technique, the mean of the participants' post-test scores significantly
exceeded that of their pre-test scores.

Table 4

Summary of Test Improvement by Instructional Method

Instructional Method	Pre-Test	Post-Test	*t*-value	*df*	*p* (one-tailed)
Text	4.28	14.33	-25.079*	94	< .001
Audio	4.59	14.43	-27.017*	112	< .001
Serious Game	4.13	11.32	-22.639*	105	< .001

* *p* < .05

Following the *t*-Tests on each of the instructional methods, a comparison of the techniques was conducted using a repeated-measures ANOVA. This analysis revealed a significant difference in the amount of improvement between the three instructional techniques (Wilk's Lambda = .889, *F*-value = 19.50, *p* < .001) (see Table 5). A review of the descriptive statistics concluded that overall, the instructional method of serious games (*M* = 11.32, *SD* = 3.51) increased knowledge at a rate significantly lower than that of both audio lectures (*M* = 14.43, *SD* = 3.38) and text reading (*M* = 14.33, *SD* = 3.57) instructional methods. Consequently, Hypothesis 1 "There is a significantly greater student test performance improvement using the instructional technique serious game play" was rejected.

Table 5

ANOVA Results for Various Instructional Techniques

Source	df	F	η	p
Between Subjects				
Instruction Type	2	20.91*	.12	< .001
Error (Time)	311	(9.72)		
Within Subjects				
Time	1	1868.86*	.86	< .001
Time x Instruction_Type	2	19.50*	.11	< .001
Error (Time)	311	(6.81)		

Note. Values enclosed in parentheses represent mean square errors.
* *p* < .05

Research Question 2A

   What is the relationship, if any, among gender and student-test performance among each of the instructional techniques?

   This question required investigating the effect of each instructional technique when the data was sorted by gender. As previously mentioned, a chi square test revealed

that gender was not independent of the instructional technique ($x^2_{(1, N=314)} = 67.77$, $p <$

.001). Additionally, it was found that the instructional technique of serious game

consisted of 86.8% female and the instructional technique of audio lecture consisted of

65.6% male. However, the analysis was still conducted with this in mind.

When separating the data by gender, the two groups comprised of 172 females

and 142 males. A repeated-measures ANOVA showed that there was no significant

interaction among the three instructional techniques for males. However, an F ratio of F

$_{(2, 169)} = 19.315$, $p < .001$ suggested that a significant interaction was found between the

techniques for females (see Table 6). An LSD post hoc test indicated that the female

group's post-test scores using the serious game technique ($M = 11.09$, $SD = 3.20$) were

significantly lower than that of the audio technique ($M = 15.36$, $SD = 2.48$) and the text

technique ($M = 14.68$, $SD = 3.49$). Therefore, Hypothesis 2 "There is a significant

difference in student test performance by gender among the instructional techniques" is

not rejected.

Table 6

ANOVA for Females Using Various Instructional Techniques

Source	df	F	η	p
Between Subjects				
Instruction Type	2	19.32*	.19	< .001
Error (Time)	169	(8.45)		
Within Subjects				
Time	1	1385.94*	.89	< .001
Time x Instruction_Type	2	33.29*	.28	< .001
Error (Time)	169	(5.15)		

Note. Values enclosed in parentheses represent mean square errors.
* $p < .05$

Research Question 2B

What is the relationship, if any, among ethnicity and student-test performance among each of the instructional techniques?

For this research question, all 314 participants indicated their ethnicity. A chi-square test was attempted to determine independence of the categories ethnicity and instructional method. However, 76.2% of the fields required to conduct a chi square test had insufficient data to complete a chi square analysis. A review of the descriptive statistics revealed that 88.5% of participants reported that they were "White, Not of Hispanic Origin." With the disproportion of reported data for the ethnicity variable, no further analysis was conducted. Consequently, a determination of whether or not to reject Hypothesis 3 "There is a significant difference in student test performance by ethnicity among the instructional techniques" could not be made.

Research Question 2C

What is the relationship, if any, among frequency of game play and student-test performance among each of the instructional techniques?

When separating out the data among the six possible categories in the Frequency of Game Play variable, only two showed signs of interaction with the variable instructional methods. For the group designated "Once a Week," a repeated-measures ANOVA showed potential interaction (Wilk's Lambda = 0.87, $F_{(2, 49)}$ = 3.59, p = .04). However, when examining the between-subjects portion of the ANOVA no significant interaction occurred.

The second category that showed potential interaction was the group designated "Once a Month." This group had 39 responses representing 12.4% of the population.

Upon performing the repeated-measures ANOVA, an F-value of $F_{(2, 36)} = 11.83, p < .001$

revealed significant interaction among the three instructional methods (see Table 7). An

LSD post-hoc test was performed and the results revealed that participants who reported

playing video games at a rate of once a month had significantly lower post-test scores

using the serious game technique ($M = 10.31, SD = 3.18$) when compared to the audio

technique ($M = 15.37, SD = 2.93$) and the text technique ($M = 15.47, SD = 3.34$).

Table 7

ANOVA for Once a Month Players Using Various Instructional Techniques

Source	df	F	η	p
Between Subjects				
Instruction Type	2	11.38*	.39	< .001
Error (Time)	36	(7.50)		
Within Subjects				
Time	1	267.3*	.88	< .001
Time x Instruction_Type	2	7.43*	.29	.002
Error (Time)	36	(5.82)		

Note. Values enclosed in parentheses represent mean square errors.
* $p < .05$

When conducting a repeated-measures ANOVA on the participants that indicated

their frequency of play was less than once every three months, Box's Test of Equality of

Covariance Matrices revealed an F-value $= 4.02, p < .001$. "A statistically significant (p

$< .05$) Box's M test indicates a homoscedasticity assumption violation" (Meyers, Gamst,

& Guarino, 2006, p. 71). Although data transformation can be used to modify the

variables that violate the homoscedasticity assumption, it can lead to formidable data

interpretation problems (Meyers, Gamst, & Guarino, 2006). Therefore, the remainder of

the analysis was conducted without attempting any data transformation. After conducting

the analysis, a significant interaction was found between various instructional techniques

(Wilk's Lambda = .833, *F*-value = 14.36, *p* < .001) (see Table 8). An LSD post-hoc test

showed significant differences among all of the instructional techniques and suggested

that the post-test scores of the participants that used the serious game method (*M* = 11.06,

SD = 3.33) performed significantly worse than those who used the audio (*M* = 14.39, *SD*

= 3.41) or text based method (*M* = 14.39, *SD* = 2.95). Therefore, Hypothesis 4 "There is

a significant difference in student test performance by frequency of game play among the

instructional techniques" is not rejected.

Table 8

ANOVA for Less than Once Every Three Months Players Using Various Instructional

Techniques

Source	df	F	η	p
Between Subjects				
Instruction Type	2	13.868*	.16	< .001
Error (Time)	143	(9.23)		
Within Subjects				
Time	1	1017.19*	.88	< .001
Time x Instruction_Type	2	14.36*	.17	< .001
Error (Time)	143	(5.82)		

Note. Values enclosed in parentheses represent mean square errors.
* *p* < .05

Research Question 2C

 What is the relationship, if any, among academic discipline and student-test

performance among each of the instructional techniques?

 This question required investigating the effect of each instructional technique

when the data was sorted by academic discipline. Academic discipline was defined as

either Social Science, Hard Science, or Professional School. Two participants did not list

their academic major and thus could not be placed into an academic discipline.

Therefore, those two cases were not included in this part of the analysis. As previously

mentioned, a chi square test revealed that gender was not independent of the instructional

technique ($x^2_{(1, N=312)}$ =.019, $p < .001$). Additionally, in this group, it was found that the

instructional technique of serious game consisted of 99.1% social science participants,

0.9% of professional school participants, and 0% hard science participants. However, the

analysis was still conducted with this in mind.

Table 9

ANOVA for Social Science Discipline Using Various Instructional Techniques

Source	df	F	η	p
Between Subjects				
Instruction Type	2	9.83*	.12	< .001
Error (Time)	140	(10.17)		
Within Subjects				
Time	1	647.63*	.82	< .001
Time x Instruction_Type	2	20.13*	.22	< .001
Error (Time)	140	(5.38)		

Note. Values enclosed in parentheses represent mean square errors.
* $p < .05$

After separating the data by discipline, the number of participants in the social

science discipline consisted of the following: 25 in Audio, 13 in Text, and 105 in Serious

Game. A repeated-measures ANOVA showed an *F* ratio of $F_{(2, 140)} = 9.831$, $p < .001$

suggesting that a significant interaction was found between the instructional methods for

participants in Social Sciences (see Table 9). After reviewing a LSD post hoc test, it was

discovered that participants in the social science academic discipline had significantly

lower post-test scores using the serious game technique ($M = 11.29$, $SD = 3.51$) when

compared to the audio technique ($M = 14.88$, $SD = 3.05$) and the text technique ($M =$

15.54, $SD = 2.54$).Therefore, Hypothesis 5 "There is a significant difference in student

test performance by academic discipline among the instructional techniques" is not rejected.

Research Question 2D

What is the relationship, if any, among self-reported preferred learning style and student-test performance among each of the instructional techniques?

For this question, the participants were asked to select their preferred method of learning according to the learning styles defined by Fleming's VARK Model (Visual, Auditory, Reading / Writing, and Kinesthetic). In theory, each person has one preferred learning style (Henry, 2007). However, since this question did not use a comprehensive learning styles questionnaire and rather let the participants self-report their preferred learning style, a number of participants indicated multiple preferred learning styles. Therefore, rather than eliminate that data, it was decided that each of the four learning styles would be analyzed as a dichotomous variable – ultimately creating four variables for preferred learning style rather than one.

When analyzing visual learning style, significant interactions were found among the instructional methods regardless of whether participants claimed to be visual learners (Wilk's Lambda = .876, *F*-value = 11.74, *p* < .001) or whether they claimed not to be visual learners (Wilk's Lambda = .848, *F*-value = 12.50, *p* < .001) (see Table 10, 11). An LSD post-hoc test of the participants that claimed to be visual learners showed that participants using the serious game instructional method (*M* = 11.21, *SD* = 3.33) did significantly worse on a post-test compared to participants using the audio method (*M* = 14.86, *SD* = 3.28) and the text method (*M* = 13.63, *SD* = 3.83). Additionally, an LSD post-hoc test of participants claiming not to be visual learners revealed similar results

$(F_{(2, 140)} = 10.16, p < .001)$. Participants claiming not to be visual learners that used the serious game method ($M = 11.46$, $SD = 3.74$) still did significantly worse that those participants using the audio ($M = 13.89$, $SD = 3.47$) and text methods ($M = 15.19$, $SD = 2.89$).

Table 10

ANOVA for Visual Learners Using Various Instructional Techniques

Source	df	F	η	p
Between Subjects				
Instruction Type	2	13.92*	.14	< .001
Error (Time)	166	(9.04)		
Within Subjects				
Time	1	924.27*	.85	< .001
Time x Instruction_Type	2	11.74*	.12	< .001
Error (Time)	166	(7.26)		

Note. Values enclosed in parentheses represent mean square errors.
* $p < .05$

Table 11

ANOVA for Non-Visual Learners Using Various Instructional Techniques

Source	df	F	η	p
Between Subjects				
Instruction Type	2	10.16*	.1	< .001
Error (Time)	140	(10.08)		
Within Subjects				
Time	1	919.21*	.88	< .001
Time x Instruction_Type	2	12.50*	.15	< .001
Error (Time)	140	(5.38)		

Note. Values enclosed in parentheses represent mean square errors.
* $p < .05$

Next, when looking at the auditory learning style using a repeated-measures ANOVA, both the participants that claimed to be auditory learners (Wilk's Lambda = .733, *F*-value = 4.11, $p = .027$) and those that claimed to not learn by audio initially

showed interaction among the three instructional techniques (Wilk's Lambda = .890, F-value = 17.19, $p < .001$). When further investigating the students who claimed to be auditory learners, although the Wilk's Lambda = .733, $F = 4.11$, $p = .027$ suggested interaction was occurring, no significant interaction was found ($F_{(2, 28)} = 1.29$, $p = .292$). Consequently, further analysis was not conducted on this group.

However, when examining the group of participants that claimed not to be auditory learners, a significant interaction was found between the different instructional techniques ($F_{(2, 278)} = 20.84$, $p < .001$) (see Table 12). An LSD post-hoc test revealed that post-test scores for this group of participants that used the serious game technique ($M = 11.28$, $SD = 3.46$) were significantly lower than the post-test scores of those that used the audio ($M = 14.40$, $SD = 3.45$) and text techniques ($M = 14.43$, $SD = 3.47$).

Table 12

ANOVA for Non-Auditory Learners Using Various Instructional Techniques

Source	df	F	η	p
Between Subjects				
Instruction Type	2	20.84*	.13	< .001
Error (Time)	278	(9.34)		
Within Subjects				
Time	1	1615.53*	.85	< .001
Time x Instruction_Type	2	17.19*	.11	< .001
Error (Time)	278	(5.38)		

Note. Values enclosed in parentheses represent mean square errors.
* $p < .05$

When analyzing the reading learning style using a repeated-measures ANOVA, a significant difference was once again found in both those groups of students who claimed to be textual based learners (Wilk's Lambda = .873, F-value = 4.37, $p = .017$) and those who claimed not to be textual based learners (Wilk's Lambda = .867, F-value = 18.93, p

< .001) (see Table 13, Table 14).   When analyzing the participants that indicated they were textual learners, Box's Test of Equality of Covariance Matrices revealed an F-value = 2.38, p = .027. "A statistically significant ($p < .05$) Box's M test indicates a homoscedasticity assumption violation" (Meyers, Gamst, & Guarino, 2006, p. 71). Although data transformation can be used to modify the variables that violate the homoscedasticity assumption, it can lead to formidable data interpretation problems (Meyers, Gamst, & Guarino, 2006). Therefore, the repeated-measures ANOVA was conducted without attempting any data transformation and significance was found between the techniques ($F_{(2, 60)} = 11.28$, $p < .001$). An LSD post-hoc test showed significant differences among all of the instructional techniques. It further suggested that the serious game method ($M = 10.27$, $SD = 3.71$) performed the worst and the text based method ($M = 15.25$, $SD = 3.18$) performed the best on the post-test.

Table 13

ANOVA for Textual Learners Using Various Instructional Techniques

Source	df	F	η	P
Between Subjects				
Instruction Type	2	11.28*	.27	< .001
Error (Time)	60	(8.30)		
Within Subjects				
Time	1	289.90*	.83	< .001
Time x Instruction_Type	2	4.37*	.13	.017
Error (Time)	60	(5.38)		

Note. Values enclosed in parentheses represent mean square errors.
Box's M = F value = 2.38, p = .03
* $p < .05$

Table 14

ANOVA for Non-Textual Learners Using Various Instructional Techniques

Source	df	F	η	P
Between Subjects				
Instruction Type	2	17.09*	.12	< .001
Error (Time)	278	(9.61)		
Within Subjects				
Time	1	1600.15*	.87	< .000
Time x Instruction_Type	2	18.93*	.13	< .001
Error (Time)	278	(6.54)		

Note. Values enclosed in parentheses represent mean square errors.
* $p < .05$

Analysis on the non-textual learner group, showed significance ($F_{(2, 278)} = 17.09$, $p < .001$) and an LSD post-hoc analysis was conducted to determine the significance of the interactions among instructional methods of the participants that claimed not to be textual learners. The LSD results showed that those participants using the serious game instructional method ($M = 11.49$, $SD = 3.47$) did significantly worse than those using the audio method ($M = 14.89$, $SD = 3.30$) and the text method ($M = 14.14$, $SD = 3.52$).

Finally, a repeated-measures ANOVA was conducted on the kinesthetic learning style. This analysis suggested a significant difference in instructional method for both the participants that claimed to be kinesthetic learners (Wilk's Lambda = .757, F-value = 9.64, $p < .001$) and those that claimed not to be kinesthetic learners (Wilk's Lambda = .899, F-value = 13.88, $p < .001$). However, although the Wilk's Lambda = .757, F-value = 9.64, $p < .001$ showed possible interaction among the instructional methods for participants claiming to be kinesthetic learners, a review of the test of between-subjects effects revealed no significant difference ($F_{(2, 60)} = 2.73$, $p = .074$). Therefore, no further analysis was conducted on this group.

The results of the repeated-measures ANOVA for participants claiming not to be kinesthetic learners were then reviewed. Similarly, a Wilk's Lambda = .899, F-value = 13.88, $p < .001$ suggested that interaction was found among the instructional methods. A review of the test of within-subjects effects and the test of between-subjects effects showed interaction as well ($F_{(2, 246)} = 20.29$, $p < .001$) (see Table 15). An LSD post-hoc test performed on participants claiming to not be kinesthetic learners revealed a significantly lower post-test score on those participants using the serious game instructional method ($M = 11.12$, $SD = 3.53$) compared to those using the audio instructional method ($M = 14.41$, $SD = 3.38$) and the textual instructional method ($M = 14.22$, $SD = 3.56$).

Table 15

ANOVA for Non-Kinesthetic Learners Using Various Instructional Techniques

Source	df	F	η	p
Between Subjects				
Instruction Type	2	20.29*	.14	< .001
Error (Time)	246	(9.36)		
Within Subjects				
Time	1	1379.51*	.85	< .001
Time x Instruction_Type	2	13.88*	.10	< .001
Error (Time)	246	(7.111)		

Note. Values enclosed in parentheses represent mean square errors.
* $p < .05$

Ultimately, when reviewing the analyses for the various learning styles, multiple differences were noted among the instructional methods. Students claiming to be visual learners and textual learners performed worse when using the serious game instructional method. Participants that claimed to not be visual learners, auditory learners, textual learners and kinesthetic learners also performed worse when using the serious game

method. Due to this, Hypothesis 2D "There is a significant difference in student test performance by learning style among the instructional techniques" is not rejected.

A summary of the key results for the statistical hypothesis (1-8) are detailed in Table 16, including power scales (η^2). A discussion of these results is presented in the next chapter.

Table 16

Key Results for Inferential Analysis of the Use of Various Instructional Methods

Dependent Variable	Independent Variable(s)	T-test or ANOVA significance (Effect Size)	Results of mean (*M*) inspection or Tukey HSD testing. Includes brief comment or interpretation.
Audio Post-Test Scores	Instructional Technique	$t(112) = -27.017$, $p<.001$ $d=(0.36)$	Students who were instructed by the audio file technique scored better on the post-test.
Text Post-Test Scores	Instructional Technique	$t(94) = -25.079$, $p<.001$ $(d=0.40)$	Students who were instructed by the text technique scored better on the post-test.
Game Post-Test Scores	Instructional Technique	$t(105) = -22.639$, $p<.001$ $(d=0.32)$	Students who were instructed by the serious game technique scored better on the post-test.
Post-Test Scores	Instructional Technique	$F(2,311)=20.914$, $p<.001$ $(\eta^2=.12)$	M(games, n=106) < M(audio or text, n=208) Student who used the serious game instructional method performed worse than the students using the other instructional techniques on the post-test.
Post-Test Scores	Instructional Technique and Gender (Female)	$F(2,169)=19.315$, $p<.001$ $(\eta^2=.18)$	M(games, n=92) < M(audio or text, n=80) Females who used the serious game instructional method performed worse than the students using the other instructional techniques on the post-test.

Post-Test Scores	Instructional Technique and Frequency of Game Play (Once a Week)	Wilk's Lambda = 0.87, F(2, 49)=3.59, p=.035 F(2,49)=1.72, p=.19 (η^2=.07)	Participants who reported playing video games once a week showed the instructional technique had an impact in their test scores (Wilk's Lambda), but the between-subjects results showed no significant difference in the different techniques.
Post-Test Scores	Instructional Technique and Frequency of Play (Once a Month)	F(2,36)=11.37, p<.001 (η^2=.39)	M(games, n=16) < M(audio or text, n=23) Participants who claimed to play video games once a month and who used the serious game instructional method performed <u>worse</u> than the students using the other instructional techniques on the post-test.
Post-Test Scores	Instructional Technique and Frequency of Play (Fewer Than Once Every Three Months)	Box's M Test = 24.653, F=4.02, p<.001 F(2,143)=13.856, p<.001 (η^2=.16)	M(games, n=62) < M(audio or text, n=84) Covariance of Matrices is not equal Those participants who claimed to play video games fewer than once every three months and who used the serious game instructional method performed <u>worse</u> than the students using the other instructional techniques on the post-test.
Post-Test Scores	Instructional Technique and Academic Discipline (Social Science)	F(2,140)=9.831, p<.001 (η^2=.12)	M(games, n=105) < M(audio or text, n=38) Participants whose majors fell into the social science academic discipline and who used the serious game instructional method performed <u>worse</u> than the students using the other instructional techniques on the post-test.

Post-Test Scores	Instructional Technique and Visual Learning Style (No)	F(2,140)=10.16, p<.001 (η²=.13)	M(games, n=48) < M(audio or text, n=95) Participants who claimed not to be visual learners and who used the serious game instructional method performed <u>worse</u> than the students using the other instructional techniques on the post-test.
Post-Test Scores	Instructional Technique and Visual Learning Style (Yes)	F(2,166)=13.92, p<.001 (η²=.14)	M(games, n=58) < M(audio or text, n=111) Participants who claimed to be visual learners and who used the serious game instructional method performed <u>worse</u> than the students using the other instructional techniques on the post-test.
Post-Test Scores	Instructional Technique and Auditory Learning Style (No)	F(2,278)=20.84, p<.001 (η²=.13)	M(games, n=94) < M(audio or text, n=187) Participants who claimed not to be auditory learners and who used the serious game instructional method performed <u>worse</u> than the students using the other instructional techniques on the post-test.
Post-Test Scores	Instructional Technique and Auditory Learning Style (Yes)	Wilk's Lambda = .733, F(2,28)=4.11, p=.027 F(2,28)=1.29, p<.292 (η²=.08)	Participants who reported as auditory learners showed the instructional technique had an impact in their test scores (Wilk's Lambda), but the between-subjects results showed no significant difference in the different techniques.

Post-Test Scores	Instructional Technique and Reading Learning Style (No)	F(2,246)=18.93, p<.001 (η^2=.13)	M(games, n=91) < M(audio or text, n=158) Participants who claimed not to be reading learners and who used the serious game instructional method performed <u>worse</u> than the students using the other instructional techniques on the post-test.
Post-Test Scores	Instructional Technique and Reading Learning Style (Yes)	Box's M Test= 15.057, F=2.381, p=.03 F(2,60)=11.28, p<.001 (η^2=.27)	Covariance of Matrices is not equal M(games, n=15) < M(audio or text, n=48) Participants who claimed to be reading learners and who used the serious game instructional method performed <u>worse</u> than the students using the other instructional techniques on the post-test.
Post-Test Scores	Instructional Technique and Kinesthetic Learning Style (No)	F(2,246)=20.29, p<.001 (η^2=.14)	M(games, n=81) < M(audio or text, n=168) Participants who claimed not to be kinesthetic learners and who used the serious game instructional method performed <u>worse</u> than the students using the other instructional techniques on the post-test.
Post-Test Scores	Instructional Technique and Kinesthetic Learning Style (Yes)	Wilk's Lambda = .757, F(2,60)=9.644, p<.001 F(2,60)=2.73, p =.074 (η^2=.08)	Participants who reported as kinesthetic learners showed the instructional technique had an impact in their test scores (Wilk's Lambda), but the between-subjects results showed no significant difference in the different techniques.

OTHER NOTES:

Instructional Technique	Gender	x^2 (1, N=314) = 67.77, p<.001	The variables Instructional Technique and Gender are <u>NOT</u> independent of each other. The instructional technique of serious game consists of 86.8% female. The instructional technique of audio lecture consists of 65.6% male.
Instructional Technique	Academic Discipline	x^2 (1, N=312) = .019, p<.001	The variables Instructional Technique and Academic Discipline are <u>NOT</u> independent of each other. The instructional technique of serious game consists of 99.1% social science. The repeated measures was still run and Hard Science and Professional Schools showed no significant difference between Text and Audio (insufficient data to compare against Games)
Instructional Technique	Ethnicty	x^2 (1, N=314) Could Not Be Calculated	The variables Instructional Technique and Gender are <u>NOT</u> independent of each other. 76.2% of cells for a Chi-Square analysis had insufficient data to be calculated. For the overall study, ethnicity consisted of 88.5% white, not of Hispanic origin. Therefore, no analysis was run on the ethnicity demographic.

Summary

This chapter reported the findings of the research study. A chi square test showed that the variables gender and academic discipline were highly related to the variable instruction method. Descriptive statistics emphasized this by showing that the serious

game instructional method was comprised of mostly females in the social science academic discipline. With this in mind, a number of repeated-measure ANOVAs were conducted to determine the impact of each instructional technique on the post-test scores of the participants. Once the data was divided into various demographic categories, additional repeated-measure ANOVAs were conducted to determine more detailed interactions. Several analyses revealed that the serious games instructional method produced significantly worse post-test scores when compared to the other instructional techniques. Additionally, an analysis to determine the impact of the various instructional methods on various ethnic backgrounds was unable to be completed to a lack of diversity in participant responses. A more detailed summary and a discussion of the findings are presented in the next chapter.

Chapter 5

Summary, Conclusions, and Recommendations

The purpose of this study was to determine the effectiveness of serious games as an instructional technique. This study compared the differences in student scores following an instructional session. Findings from comparisons between the instructional techniques of audio lecture, textual reading, and serious games will be reported. Demographic information will be used to report findings about whether certain students perform better under each instructional technique.

Research Questions

1. What are the differences in student test performance upon the completion of one of the following instructional techniques: audio lecture, text reading, or serious games?

2. What is the relationship, if any, among demographic variables (age, gender, game-play frequency, etc) and student-test performance among each of the instructional techniques?

Study Synopsis

This chapter presents a summary of the completed research, review of the research findings, conclusions, and discussion of the significant findings. Implications of the research and recommendations for future research are also included at the end of this chapter.

The video game industry has seen unparalleled growth of the last couple of decades (Entertainment Software Association, 2010). This is of little surprise when one compares the characteristics of video games with the desires of our digital native population, the current generation of technology-savvy individuals. Video game elements such as enhanced aesthetics, social interactivity, and incorporating pragmatic are similar to characteristics found in many of today's younger populations (Oblinger, 2003; Oblinger & Oblinger, 2005; Prensky, 2001). With these digital native populations eagerly playing video games, the thought of using video games as learning tools has gained popularity. Using video games as instructional tools, called serious games, could help solve the dilemmas of student motivation discussed by Balduf (2009). Additionally, Becker (2007) described how typical video games incorporate every event of Gagné's nine events of instruction in their design. Therefore, from an instructional design perspective, a video game could serve as an instructional tool. However, their validity as an effective tool must first be determined. The purpose of this study was to determine the effectiveness of serious games as an instructional tool. The results of this study will contribute to the body of knowledge surrounding the serious game area. Another outcome of this study will be to help determine the feasibility of a serious game as an instructional tool and provide insight into potential pedagogical uses for the tool.

Determining the effectiveness of a serious game in all possible educational scenarios is impossible for one project. Therefore, this study focused on using common educational theories. The driving theories influencing the design of this project were Bloom's Taxonomy of Educational Objectives and Gagné's Events of Instruction. The study focused on the first class of Bloom's Taxonomy – the knowledge construct.

Additionally, the study used the first five steps of Gagné's theory, which are concerned with knowledge acquisition rather than retention. Therefore, this study centered on a serious game's ability to effect immediate knowledge acquisition and short term memorization.

The population of this study consisted of undergraduate college students at a large, public four-year research institution in the southeastern United States. The participants were already enrolled in their regular course of study at the university. Thus, though the researcher randomly chose the courses to include in the study, the actual participants were not selected at random. Therefore, the nature of this experiment was quasi-experimental.

Since the review of literature showed a gap in the knowledge base and a lack of experimental data on whether serious games helped with knowledge acquisition, the objective of the research project was to investigate knowledge acquisition. Instruments for the study were developed by a tenured faculty member who had expertise in the area of crop domestication. The materials developed included a pre-test and post-test on crop domestication, an audio and text lecture covering the material, and a serious game covering the material (see Appendix A-D). All of the instruments were then reviewed and validated by a panel of experts, each possessing specific expertise in various specialty areas of agriculture (see Appendix E).

Data were collected and analyzed during the fall semester of 2010. The researcher acquired approval from the instructors of the courses targeted for inclusion in the study. Upon receiving permission to gather data in the various courses, the researcher attended one class session of each course and was allotted 20 minutes to perform the

experiment and gather the necessary data. Overall, a total of 340 students took part in the study. Of those participants, 26 were omitted from the analysis due to being under the age of majority and failing to return a completed parental consent form required for informed consent.

Descriptive statistics, *t*-tests, and multiple repeated-measures ANOVAs were used to determine the effectiveness of serious games as an instructional tool. Chi-square analyses were also conducted to determine the independence of each variable. The study's findings were drawn from data that was analyzed as it related to the six research questions.

<div align="center">Conclusions</div>

Blunt (2009) sought to determine a Return on Learning (ROL) measure when teaching using serious games. He conducted an empirical study using three university level business courses and found that, although serious games did not always increase student learning, "at least in some circumstances, the application of serious games significantly increases learning" (Blunt, 2009, p.5). However, in constrast to Blunt's study, this study did not find any instances of where serious games increased student learning. Furthermore, this study suggests that in given scenarios, serious games can actually hinder student learning rather than improve it when compared to traditional instructional methods.

When conducting a data independence check for this study, it was found that a couple of the variables in the study were related to one another. The group of participants that used the serious game instructional method consisted of 86.8% females and 99.1% of social science majors. This must be taken into account before any

generalization of the study can be made. By accounting for this lack of independence, any results derived regarding the effectiveness of serious games could only be generalized to individuals that are female social science majors using serious games. However, with that in mind, this study does offer a brief insight into the effectiveness of serious games when compared to the instructional methods of audio lecture and textual reading.

The first analysis conducted attempted to validate some of the ideas and suggestions of researchers such as Prensky (2005, 2006), Gee (2007), and Squire (2004). The findings suggest that a serious game could be used as an effective instructional tool. As evident in the results of the *t*-tests conducted on each of the instructional methods, the serious game instructional method seemed to impart knowledge on the participants just as the audio lecture and textual reading. On average, participants using the serious game instructional method improved their test scores approximately seven points on an 18 point assessment. This proved to be a significant increase.

Although serious games significantly increased the participants test scores, it did not fare as well when compared to the increases found with the other two instructional techniques. An LSD post-hoc analysis of the three instructional techniques showed that the participants using the serious game performed statistically significantly poorer on the post-test assessment when compared to participants using the audio lecture and textual reading techniques (see Figure 1). Therefore, although serious games can be used to teach students, they do not appear to be as effective at teaching students when set within the limitations of this study.
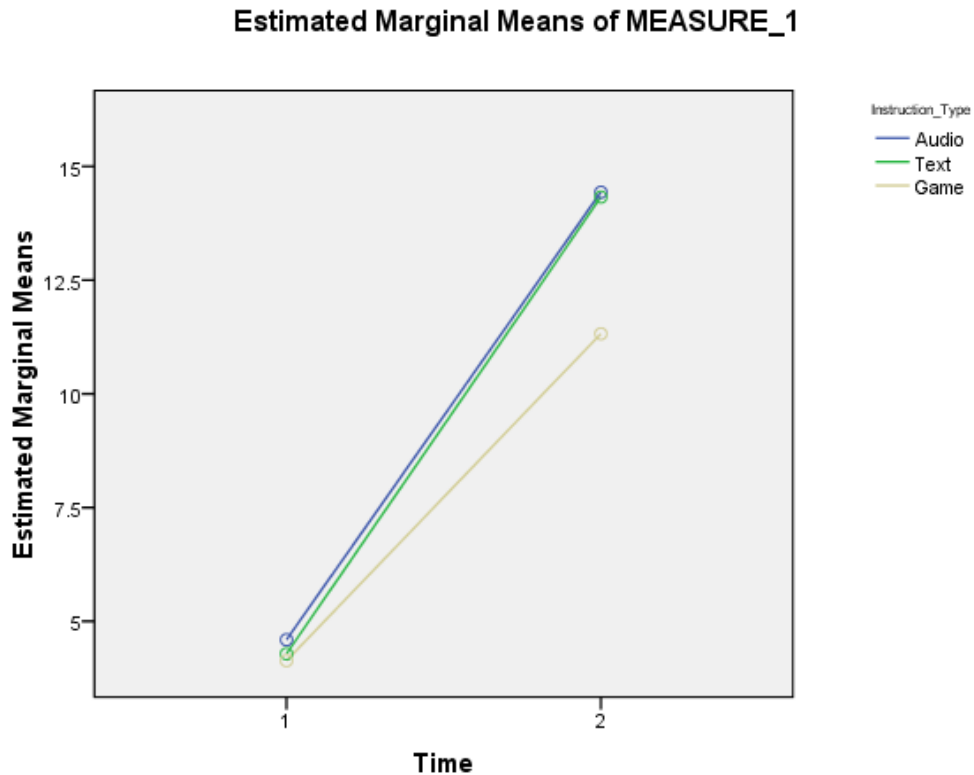
Estimated Marginal Means of MEASURE_1

Figure 1. Overall effects of the three instructional methods.

Once the overall analysis was conducted to determine the effectiveness of serious games as teaching tools, other analyses were performed in order to determine if certain demographical characteristics of participants could suggest better benefit from the use of a serious game. The first characteristic observed was related to gender. When disaggregating the data by gender, it again appeared that both males and females benefited from using a serious game. However, when compared to the audio and text instructional techniques, females that used the serious game seemed to do significantly worse on their post-test when compared to the other two instructional techniques. For males, there was no significant difference found among the three instructional techniques. Thus, the findings suggest that females would better benefit from using audio lecture and

textual readings than serious games. Males will generally acquire the same amount of knowledge regardless of instructional method.

The next demographic variable compared was ethnicity. However, upon collecting and analyzing the data it was apparent that a lack of diversity would make this comparison statistically problematic, if not impossible. Overall, 88.5% of the participants were reported as "White, Not of Hispanic Origin". Additionally, five out of the possible seven ethnicities to choose from on the survey contained less than five responses. Thus a chi-square analysis was conducted and further demonstrated that a lack of diversity would make analysis of this variable ineffective. Therefore, no further analysis on ethnicity was conducted.

Following ethnicity, the study looked at determining if a participant's frequency of game play would affect their post-test performance among the three instructional techniques. The results showed no significant difference among the instructional techniques for those participants that reported to play video games at a rate of more than once a week. The Wilk's Lambda score (Wilk's Lambda = 0.87, $F(2, 49) = 3.59$, $p = .04$) indicated potential interaction for participants claiming to play games at a rate of once a week; however, further review of the repeated-measures ANOVA showed no significant interaction. Lastly, those participants that claimed to play video games at rate of once a month or less showed significant difference between the different instructional techniques. LSD post-hoc analyses revealed that these participants performed significantly worse on their post-test assessments when using the serious game technique compared to that of the audio lecture technique and the textual reading technique. Consequently, the findings would suggest that students who tend to play video games

frequently would acquire knowledge from a serious game, audio lecture, or text reading at the same rate. However, students that do not frequently play video games would benefit more from the audio lecture instructional method or the textual reading instructional method rather than that of a serious game.

The next variable tested was that of academic discipline. The hard science and professional school disciplines both contained less than 1% of students using the serious game instructional method. Thus, the analyses conducted on these two disciplines did not include the serious game method. A repeated-measures ANOVA was still conducted in order to determine whether or not a significant interaction was found between the audio lecture technique and textual reading technique for these two disciplines. As most of the trends to this point indicated, no significant interaction was found between these two instructional techniques. Therefore, students majoring in both hard science disciplines and professional school disciplines acquire knowledge at the same rate when being taught via audio lecture and textual reading.

For students in the social sciences, the repeated-measures ANOVA included all three instructional techniques. The analysis showed a significant difference between the three instructional techniques. An LSD post-hoc test revealed that participants using the serious game instructional method performed statistically significantly poorer on their post-test assessment than those participants using the audio lecture and textual reading instructional techniques. Consequently, the findings suggested that, within the constraints of this experiment, students in the social science disciplines would benefit more from audio lectures and text readings than serious games.

The final demographic variable that was tested was preferred learning style. Due to time constraints allowed in each classroom during the data collection phase, participants were asked to self report their preferred learning style rather than complete a time intensive learning style inventory. Although the learning styles question on the instrument was designed as a multiple choice question intended to elicit one answer from participants, a number of participants indicated multiple preferred learning styles. Due to these unexpected results, the researcher decided to evaluate the four preferred learning styles – visual, audio, reading, kinesthetic – as separate dichotomous variables.

A review of the analyses conducted on the visual learning style showed that participants claiming to be visual learners performed significantly worse on the post-test assessment when learning via the serious game instructional method. Additionally, participants that claimed not to be visual learners also performed significantly worse when using serious games. Therefore, according to the findings, regardless of whether or not a person claims to be a visual learner, audio lecture and textual readings will be more beneficial to knowledge attainment when compared to that of a serious game.

When observing the results of participants with an auditory learning style, initial findings indicated that interaction was found between the three instructional methods for both those participants that claimed to be auditory learners and those who claimed not to learn best by audio. When further analyzing the repeated-measures ANOVA of participants who claimed to be auditory learners, no significant interaction was found. Thus, on average, students claiming to be auditory learners acquire knowledge at the same rate regardless of whether or not the instructional method is audio lecture, text reading, or serious game.

Although those participants who indicated they are auditory learners showed no significant difference between the instructional methods, those participants claiming not to be auditory learners did show differences on their post-test assessments depending on which instructional method they used. Those participants using the serious game instructional technique performed significantly worse on their post-test assessments compared to those participants using the other two instructional methods. Therefore, the findings suggest that those students who are not auditory learners would benefit more from the use of an audio lecture or textual reading than that of a serious game.

The third set of analyses conducted on participants' learning styles was that of the reading / textual learning style. For participants who were reading / textual learners, significant differences were found among the instructional techniques used. An LSD post-hoc test showed differences among all three instructional methods. Those participants that used the serious game instructional method performed significantly worse than participants that used that textual reading and audio lecture methods. However, participants that used the textual reading technique scored significantly higher on their post-test assessment when compared to both those participants using the audio technique and those using the serious game. Consequently, the data confirms the idea that students claiming to be reading / textual learners will benefit the most from a textual reading instructional technique.

An analysis of participants who do not learn best by reading / textual instructional methods also showed significant interaction in their post-test scores when using the different instructional techniques. The LSD post-hoc analysis showed that the participants using the serious games instructional method performed significantly worse

on their post-test assessments when compared to the participants using the other two instructional methods. Therefore, students claiming not to be textual / reading learners would benefit most from using either auditory or textual reading instructional methods rather than that of serious games.

Finally, a set of analyses were conducted to evaluate the kinesthetic learning style. For learners claiming to be kinesthetic learners, possible interaction was suggested (Wilk's Lambda = .757, *F*-value = 9.64, *p* < .000); however, the test of between-subjects effects revealed no significant interaction among the different instructional methods. Therefore, learners who are kinesthetic learners acquire knowledge at approximately the same rate regardless of whether the instructional technique is audio lecture, textual reading, or serious game.

A repeated-measures ANOVA on those students claiming not to be kinesthetic learners suggested that significant differences on the post-test assessment scores were found among the various instructional techniques. An LSD post-hoc analysis revealed that participants using the serious game instructional technique performed significantly worse than those participants using either the audio lecture or the textual reading instructional method. Thus, students claiming not to be kinesthetic learners would benefit more from either the audio lecture instructional technique or the textual reading technique rather than that of the serious game method.

In conclusion, the results of this study show that although serious games can improve knowledge acquisition among students, it does so at a lower rate than that of the traditional teaching methods of audio lecture and textual reading. In some instances, the differences between the three instructional techniques were not significant. However,

more often than not, serious games proved to be statistically significantly less effective than other instructional methods. In no scenario did serious games significantly increase the amount of knowledge gained when compared to the other two instructional methods.

Implications and Recommendations

Although the results of this study show that serious games may not be as effective in transmitting information to students as other methods of instruction, it is once again important to note the limitations of this study. This study focused on pure knowledge acquisition with no investigation into other areas of Bloom's Taxonomy such as evaluation and synthesis. Additionally, the study focused only on initial knowledge acquisition and did not investigate whether or not retention of knowledge was enhanced by serious games. Although serious games may not be an idea instructional method for this sort of short term knowledge acquisition, it still could be an effective instructional tool in other constructs and situations.

Findings from this study point to several implications for practice and future research. The results from this study can benefit students, faculty members, serious game developers, and researchers when investing in or developing serious games.

Practice Implications

The results of this study show a number of suggestions that should be taken into account when developing or selecting a serious game for use in the classroom. First and foremost, the study shows that serious games may not be appropriate to use in every educational situation. For situations dependent on the lower levels of Bloom's Taxonomy and short term knowledge acquisition, such as reviewing key concepts or introducing new definitions, serious games may actually prove more detrimental than the

use of traditional forms of instruction such as audio lecture or textual readings. Therefore, in these situations, instructional material should be presented in either audio lecture or textual reading rather than in serious game form.

Although the results of the study may suggest that serious games do not perform as well as audio lecture and textual reading in direct knowledge acquisition, it did still show that serious games increased the amount of knowledge acquired by the participants. Due to this, it may be prudent to use serious games as supplemental reinforcement tools in courses since participants ultimately benefited from this type of instruction as well.

Although it might seem wise to use serious games as supplemental material, the complexity of serious games compared to audio lectures and textual readings would suggest that training and education should be undertaken before implementing this tool into a classroom. For that reason and the fact that serious games showed an increase in knowledge acquisition, it would seem sensible to add elements of serious game creation and management into the curriculum. Just as elements of course management, lecturing, and curriculum design are embedded in education programs to enhance the overall quality of graduates, serious game elements should also be incorporated. As the research regarding serious games continues to develop, more and more emphasis could be placed on the incorporation of this field into education programs.

Lastly, when serious games are to be developed, certain demographic characteristics appear to benefit more from this tool. For example, when using serious games for short term knowledge acquisition, males have better results than females on post-test assessments. Additionally, students that claim to play games more frequently than once a month tended to yield better result on post-test assessments. Consequently,

when developing serious games for this purpose, elements of those games may want to be designed towards expectations of male, experienced game players as they appeared to benefit most from this instructional method.

Future Research

This study presents a number of possibilities for future research that could help better understand the impact that serious games have on instruction and education. The following research topics are a few that could be considered as follow-up studies related to this project:

1. The chi-square analyses showed data dependence on a number of variables. This study could be replicated using a more diverse sample allowing for more generalizability.

2. Due to the allotted time to gather data in the classroom, the participants' preferred learning styles were self-reported. This study could be replicated allowing for participants to complete a validated learning styles inventory to better determine their preferred learning style and help validate the findings between learning style and instructional method.

3. Due to the allotted time to gather data in the classroom, participants were only allotted four to five minutes to review the instructional material. This may have resulted in lower scores for the serious game instructional tool due to a higher learning curve involved with using the tool. This study could be replicated allowing for more time with the instructional tool in order to determine whether or not the increased time on task would affect the averages of the post-test

assessment scores and result in less of a difference between the three instructional methods

4. This experiment only allowed the participant to rely on their knowledge and learning strategies. As seen in the review of literature, the digital native population view themselves as social creatures. This study could be replicated incorporating elements of teamwork and collaborative learning to see if serious games can serve as an effective instructional tool in a collaborative environment.

5. This study focused only on the lower classes of Bloom's Taxonomy. Future studies may want to look at whether or not serious games serve as effective instructional tools in the higher order levels of Bloom's Taxonomy.

6. This study focused on the first five steps of Gagné's events of instruction. This study could be replicated using a longer period of time and all of the events of instruction in order to determine whether or not serious games can effectively enhance retention of information acquired.

7. The design of this study used one dependent variable (overall test scores) and multiple independent variables (instructional methods and various demographic data). It is possible that some of the demographic variables (gender, academic discipline, frequency of gameplay) could be covariate variables. Improper recognition of covariates can lead to a misinterpreted conclusion (Meyers, Gamst, & Guarino, 2006, p. 26). Therefore, future studies may consider designing a study to test the possibility of various demographic variables serving as a covariate rather than an independent variable.

Summary

The findings of this study suggest that serious games may not be as effective of an instructional tool when compared with audio lecture and textual readings, particularly for short term knowledge acquisition. It also appears that certain student demographic categories may benefit from the use of serious games more than others. Both males and those students who play video games at a rate of at least once a week will not be significantly impacted when using serious games for short term knowledge acquisition. However, serious games do not provide any benefit to these students either when compared to audio lectures and textual readings. Ultimately, in most cases, although serious games did improve short term knowledge acquisition, it did so at a rate significantly poorer than audio lecture and textual reading, which are the cheaper and easier methods of instructional delivery.

Although findings from this study suggest that serious games do not help student learning as much as traditional forms of instructional delivery, further research should be conducted to enhance the validity and generalizability of this research. Corrections in sampling and data collection procedures could enhance the outcomes of future studies related to this project. Also, further exploration into the effect of serious games in the higher levels of Bloom's Taxonomy or later stages of Gagné's events of instruction could yield promising results for this developing area of study.   With further research, the notions presented by Prenksy (2005, 2006) and Gee (2007) may yet be validated for improving instruction and education.

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Appendices

Appendix A

WRITTEN FORM OF INSTRUCTIONAL TEXT

Crop Domestication Textual Reading and Audio Lecture

There are literally hundreds of crops that have been domesticated and are cultivated in various parts of the world. Certain crops, like wheat, are very widely used and adapted today, and are grown on every continent. But all crops in pre-agricultural times were usually confined to relatively small areas, and many were in forms that are very different from what we are familiar with today. The ancestors of maize, for example, look very different from the crop we know today. Crop domestication regions can be broadly divided into four major areas that coincide with the early areas of agricultural development. These are Southeast Asia, Southwest Asia, Africa, and the Americas. It should be no surprise that rice originated in Southeast Asia (including China and what is now Indo-China) along with citrus, banana, soybean, and coconut. From the Middle East (including Iraq and Syria) we get the small grains wheat and barley, plus lentils and peas. Africa is a large continent well-separated from the rest of the world, and from there we get watermelon, coffee, and okra. Even further isolated from the rest of the world are the Americas, North and South. Many crops from this diverse north-south region originated in widely separate areas of these two continents, but were being widely grown all over the Americas by the time of the arrival of Columbus. These include maize (corn), peanut, tomato, white potato, sweet potato, pumpkin, and the common bean. Other regions of the world, including Greenland, Europe, Russia, Northern China, and Australia, did not have any sophisticated domestication of early major crops. Even though many of these crops may be found almost anywhere in the world today, each started out in its own particular corner of the globe, and were selected over the course of thousands of years as an experiment by mankind to find out which plant species were best able to meet our needs.

Appendix B

SCREENSHOT OF SERIOUS GAME
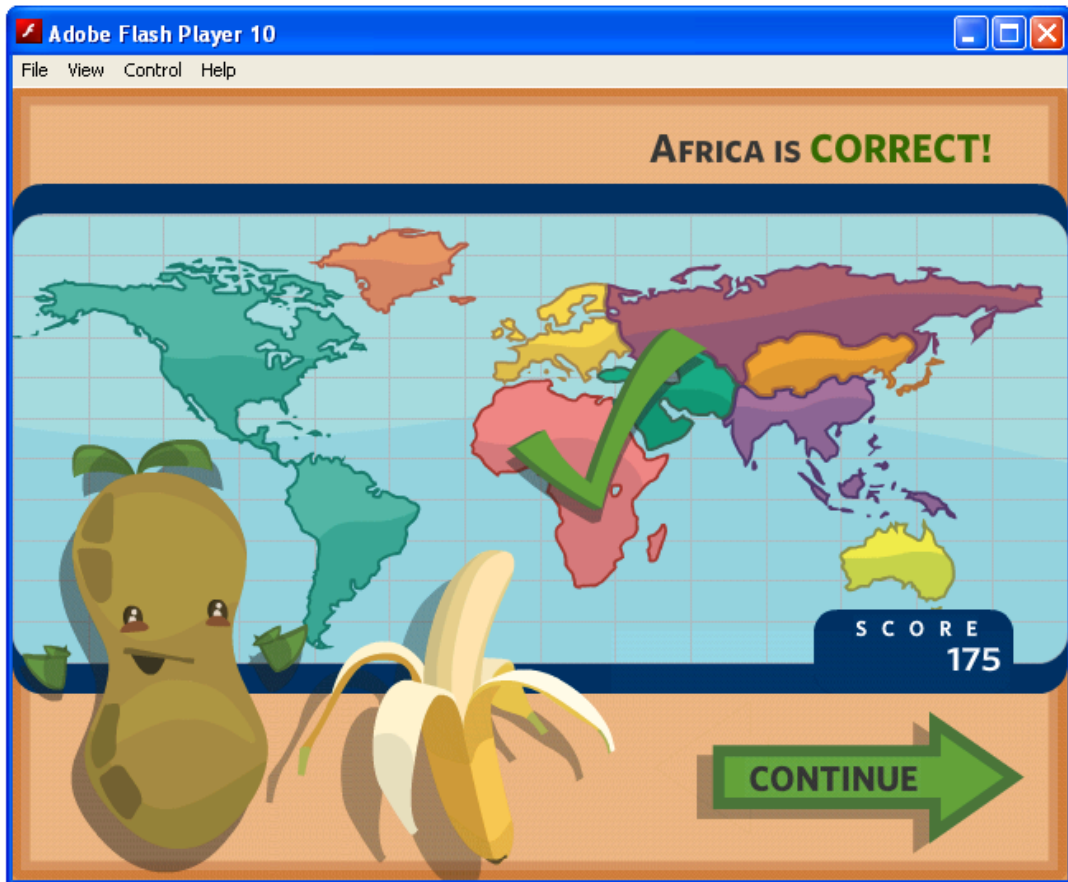
Appendix C

PRE-TEST INSTRUMENT

Crop Domestication Pre-Test

For each of the following crops, please write the corresponding letter of the region where the crop was domesticated:

Domestication Regions:

 a. Americas
 b. Greenland
 c. Europe
 d. Africa
 e. Russia
 f. Northern China
 g. Middle East
 h. Southeast Asia
 i. Australia

1. Pea: _____
2. Barley: _____
3. Soybean: _____
4. Orange: _____
5. Peanut: _____
6. Watermelon: _____
7. Okra: _____
8. Sweet Potato: _____
9. Pumpkin: _____
10. Lentils: _____
11. Tomato: _____
12. Wheat: _____
13. Corn: _____
14. Coconut: _____
15. Common Bean: _____
16. Rice: _____
17. Coffee: _____
18. Banana: _____

Please indicate your gender:

    a. Male

    b. Female

Please indicate your ethnicity:

    a. Native American

    b. White, not of Hispanic origin

    c. Hispanic

    d. Black, not of Hispanic origin

    e. Asian / Pacific Islander

    f. Multi-racial

    g. Other

Please indicate the closest option indicating the frequency of which you play video games for entertainment purposes:

    a. Multiple Times a Day

    b. Once a Day

    c. Once a Week

    d. Once a Month

    e. Once Every Three Months

    f. Fewer Than Once Every Three Months

Appendix D

POST-TEST INSTRUMENT

Crop Domestication Post-Test

For each of the following crops, please write the corresponding letter of the region where the crop was domesticated:

Domestication Regions:
    j. Americas
    k. Greenland
    l. Europe
    m. Africa
    n. Russia
    o. Northern China
    p. Middle East
    q. Southeast Asia
    r. Australia

19. Banana: _____

20. Barley: _____

21. Coconut: _____

22. Coffee: _____

23. Common Bean: _____

24. Corn: _____

25. Lentils: _____

26. Okra: _____

27. Orange: _____

28. Pea: _____

29. Peanut: _____

30. Pumpkin: _____

31. Rice: _____

32. Soybean: _____

33. Sweet Potato: _____

34. Tomato: _____

35. Watermelon: _____

36. Wheat: _____

Please indicate your intended college major:

_____

Please indicate the number of unique video games you have played in the past year:

_____

Please indicate what you feel your PREFERRED method of learning is:

g. Visual (pictures, visual aids, diagrams, etc.)

h. Auditory (lecture, discussions, tapes, etc.)

i. Reading / Written

j. Kinesthetic / Tactile (active exploration, science projects, experiments, etc.)
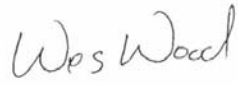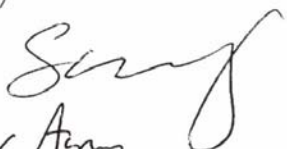
Appendix E

PANEL REVIEW CONFIRMATION

This document is to confirm the review of the following items:

1. Crop Domestication Lecture Text
2. Crop Domestication Video Game
3. Crop Domestication Quiz

Upon review, it has been determined that the information reflected in the Crop Domestication Quiz is sufficiently covered and explained by both the Crop Domestication Lecture Text and the Crop Domestication Video Game. Therefore, the Crop Domestication Quiz is approved for use as an instrument to determine whether or not the content of the Crop Domestication Lecture Text or the Crop Domestication Video Game has been obtained by the student.

By signing this document, you are confirming the above statement as true.

Please include your name (print), job title, signature and the date.

1. ELizabeth Guertal —
   Professor, Agronomy
   7/12/10

2. Wes Wood
   Professor, Agronomy
   7/12/10

3. Julie Howe
   Assistant Professor, Agronomy
   7/14/10

4. Scott McElry
   Associate Professor, Agrny
   7/20/10

Appendix F

INSTITUTIONAL REVIEW BOARD (IRB) DOCUMENTS

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**(NOTE: DO NOT AGREE TO PARTICIPATE UNLESS AN IRB APPROVAL STAMP
WITH CURRENT DATES HAS BEEN APPLIED TO THIS DOCUMENT.)**

INFORMATION LETTER
for a Research Study entitled
*"Game Play in Higher Education: The Use of Serious Games vs Traditional
Instructional Methods in Learning"*

You are invited to participate in a research study to attempt to determine whether or not the use of a serious game as an instructional method is as or more effective than the traditional instructional techniques of audio lecture and text reading. Additionally, we would like to determine whether or not certain student populations, as determined by demographic information, would benefit from the use of serious games. The study is being conducted by Mark Thomas Gale, Doctoral Candidate, under the direction of Dr. David DiRamio, Associate Professor in the Auburn University Department of Education Foundations, Leadership and Technology. You were selected as a possible participant because you are enrolled in one of the courses selected to be surveyed in this study and are age 19 or older.

If you are age 18 or younger, please indicate so on the raffle sign up included with this document. You will be given a parental consent document that must be completed and returned to that address on the document in order for your data to be included in the study and for you to be eligible for inclusion in the raffle drawing.

What will be involved if you participate? If you decide to participate in this research study, you will be asked to complete a pre-test; receive instruction via audio lecture, text reading, or serious game; and complete a post-test. Your total time commitment will be approximately 20 minutes.

Are there any risks or discomforts? The risks associated with participating in this study are breach of confidentiality and coercion. To minimize the risk of breach of confidentiality, participants will not put their names on the documents. Each participant will be randomly assigned a participant identification number in order to help protect their identity. We will also securely store all information which can be linked back to the participant. Upon completion of the study, all identifying data will be destroyed. Additionally, the number of participants we are intending to involve in the study should minimize the risk of breach of confidentiality. For the risk of coercion, the instructor will be asked to leave the class prior to the start of the study and the instructor will in no way no whether or not a student participated in the study.

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Additionally, all of the instructors of the courses involved in the study have agreed that no extra credit will be given as an incentive to participate in the study.

Will you receive compensation for participating? To thank you for your time you will be offered inclusion in a raffle for a $50 Wal-Mart gift card. Chances of winning the raffle are between 1:100 and 1:500, depending on the number of participants in the study.

Are there any costs? If you decide to participate, you will not incur any costs other than the cost of postage to mail a parental consent document to the address found at the bottom of that document if necessary.

If you change your mind about participating, you can withdraw at any time during the study. Your participation is completely voluntary. If you choose to withdraw, your data can be withdrawn as long as it is identifiable. Your decision about whether or not to participate or to stop participating will not jeopardize your future relations with Auburn University or any of the departments involved in this study.

Any data obtained in connection with this study will remain anonymous. We will protect your privacy and the data you provide by The data collected will be protected by use of a coding system to add a level of anonymity between the data set and any identifying information found on the research instruments. All original copies of the data collection instruments will be kept in a secure location and will be destroyed either after one year or the lifetime of the approval of this study. Information collected through your participation may be used to fulfill the educational requirements for a Ph.D. in Higher Education Administration and may be used in journal publications or presentations at professional meetings.

If you have questions about this study, contact Mark Thomas Gale at mark.gale@auburn.edu (256-665-4724) or Dr. David DiRamio at diramdc@auburn.edu (334-844-4460).

If you have questions about your rights as a research participant, you may contact the Auburn University Office of Human Subjects Research or the Institutional Review Board by phone (334)-844-5966 or e-mail at hsubjec@auburn.edu or IRBChair@auburn.edu.

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HAVING READ THE INFORMATION PROVIDED, YOU MUST DECIDE IF YOU WANT TO PARTICIPATE IN THIS RESEARCH PROJECT. IF YOU DECIDE TO PARTICIPATE, THE DATA YOU PROVIDE WILL SERVE AS YOUR AGREEMENT TO DO SO. THIS LETTER IS YOURS TO KEEP.

_____ 9/15/10 _____
Investigator's signature   Date   Print Name   Mark Gale

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(NOTE: DO NOT AGREE TO PARTICIPATE UNLESS AN APPROVAL STAMP WITH CURRENT DATES HAS BEEN APPLIED TO THIS DOCUMENT.)

PARENTAL PERMISSION/CHILD ASSENT
for a Research Study entitled
"Game Play in Higher Education: The Use of Serious Games vs Traditional Instructional Methods in Learning"

Your child is invited to participate in a research study to attempt to determine whether or not the use of a serious game as an instructional method is as or more effective than the traditional instructional techniques of audio lecture and text reading. Additionally, we would like to determine whether or not certain student populations, as determined by demographic information, would benefit from the use of serious games. The study is being conducted by Mark Thomas Gale, Doctoral Candidate, under the direction of Dr. David DiRamio, Associate Professor in the Auburn University Department of Education Foundations, Leadership and Technology. Your child was selected as a possible participant because he or she is enrolled in one of the courses selected to be surveyed in this study. Since your child is age 18 or younger we must have your permission to include him/her in the study.

What will be involved if your child participates? If you decide to allow your child to participate in this research study, your child will be asked to complete a pre-test; receive instruction via audio lecture, text reading, or serious game; and complete a post-test. Various classes will be used in this study and the instructional technique used by each participant is predetermined by the researcher based on the class the participant is enrolled in. Your child's total time commitment will be approximately 20 minutes. Permission has been obtained by the instructor of the course to make sure your child's academic progress in the course is in no way impeded by participation in this study.

Parent/Guardian Initials_____   Participant Initials_____

1 of 3

The Auburn University Institutional
Review Board has approved this
document for use from
___9/10/10___ to ___9/9/11___
Protocol # 10-244 EP 1009

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Are there any risks or discomforts? The risks associated with participating in this study are breach of confidentiality and coercion. To minimize the risk of breach of confidentiality, participants will not put their names on the documents. Each participant will be randomly assigned a participant identification number in order to help protect their identity. We will also securely store all information which can be linked back to the participant. Upon completion of the study, all identifying data will be destroyed. Additionally, the number of participants we are intending to involve in the study should minimize the risk of breach of confidentiality. For the risk of coercion, the instructor will be asked to leave the class prior to the start of the study and the instructor will in no way no whether or not a student participated in the study. Additionally, all of the instructors of the courses involved in the study have agreed that no extra credit will be given as an incentive to participate in the study.

Will you or your child receive compensation for participating? To thank your child for participating, your child will be included in a raffle for a $50 Wal-Mart gift card. Chances of winning the raffle are between 1:100 and 1:500.

Are there any costs? If you decide to allow your child to participate, you will not incur any costs other than the cost of postage to mail this consent document to the address found at the bottom of the document.

If you (or your child) change your mind about your child's participation, your child can be withdrawn from the study at any time. Your child's participation is completely voluntary. If you choose to withdraw your child, your child's data can be withdrawn as long as it is identifiable. Your decision about whether or not to allow your child to participate or to stop participating will not jeopardize you or your child's future relations with Auburn University or any of the departments involved in this study.

Your child's privacy will be protected. Any information obtained in connection with this study will remain confidential. All original copies of the data collection instruments will be kept in a secure location. Anonymous data collect from your child will be destroyed either after the study is complete. Information obtained through your child's participation may be used to fulfill the educational

Parent/Guardian Initials_____   Participant Initials_____

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requirements for a Ph.D. in Higher Education Administration and may be used in journal publications or presentations at professional meetings.

If you (or your child) have questions about this study, contact Mark Thomas Gale at mark.gale@auburn.edu (256-665-4724) or Dr. David DiRamio at diramdc@auburn.edu (334-844-4460).   A copy of this document will be given to you to keep.

If you have questions about your child's rights as a research participant, you may contact the Auburn University Office of Human Subjects Research or the Institutional Review Board by phone (334)-844-5966 or e-mail at hsubjec@auburn.edu or IRBChair@auburn.edu.

HAVING READ THE INFORMATION PROVIDED, YOU MUST DECIDE WHETHER OR NOT YOU WISH FOR YOUR CHILD TO PARTICPATE IN THIS RESEARCH STUDY. YOUR SIGNATURE INDICATES YOUR WILLINGNESS TO ALLOW YOUR CHILD TO PARTICIPATE. YOUR CHILD'S SIGNATURE INDICATES HIS/HER WILLINGNESS TO PARTICIPATE.

Please mail or deliver this completed document to the following address in order to allow your child to participate in the study.

> Mark Gale
> 137 Fuller Ave.
> Auburn, AL 36830

_____   _____
Participants' Signature and Date   Participant's printed name

_____   _____
Parent/Guardian Signature and Date   Parent/Guardian printed name

Mark Gale   9/27/10
Mark Gale, Investigator Obtaining Consent - Signature and Date

The Auburn University Institutional Review Board has approved this document for use from 9/10/10 to 9/9/11 Protocol # 10-244 EP 1009

3 of 3

4036 Haley Center, Auburn, AL 36849-5221; Telephone: 334-844-4460; Fax: 334-844-3072

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