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Educational Video Game Effects Upon Mathematics Achievement and Motivation Scores: An Experimental Study Examining Differences Between the Sexes

Wendi M. Kappers
Embry-Riddle Aeronautical University, kappersw@erau.edu

EDUCATIONAL VIDEO GAME EFFECTS UPON MATHEMATICS ACHIEVEMENT AND MOTIVATION SCORES: AN EXPERIMENTAL STUDY EXAMINING DIFFERENCES BETWEEN THE SEXES

by

WENDI M. KAPPERS
B.A., Notre Dame College, 1996
M.S., University of Phoenix, 2003

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ABSTRACT

An experimental research study using a mixed-method analysis to was conducted to examine educational video game effects on mathematics achievement and motivation between sexes. This study examined sex difference in a 7^{th} grade mathematics (Mathematics 2/Mathematics 2 Advanced) classroom (n=60) learning algebra. Attributes and barriers relating to educational video game play, preference, and setting characteristics were explored.

To examine achievement and motivation outcomes, a repeated-measure (SPSS v14) test was used. The analysis included ethnographic results from both student and teacher interview and observation sessions for data triangulation. Results revealed a statistically significant academic mathematics achievement score increase ($F = 21.8$, $df = 1, 54$, $p < .05$). Although, mathematics class motivation scores did not present significance ($F = .79$, $df = 1, 47$, $p > .05$), both sexes posted similar data outcomes with regard to mathematics class motivation after using an educational video game as treatment during an eighteen-week term in conjunction with receiving in-class instruction. Additionally, there was an increase in male variability in standard deviation score ($SD_{motivationpre} = 8.76$, $SD_{motivation\ post} = 11.70$) for mathematics class motivation.

Lastly, self-reported differences between the sexes for this limited sample, with regard to game design likes and dislikes and observed female game play tendencies, were also investigated. The data presented *customization* as a unified, but most requested, game design need between the sexes. Between sex differences were found only to be superficial other than a female delay in game acceptance with regard to time and game play comfort.

I dedicate this dissertation to my always loving and patient husband and to our furry brood that we call “our kids,” as their sacrifice of my time and attention will never be forgotten!

Michael, “what’s this to? And, what’s next?”

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In loving memory of our Bailey! She'll be missed.

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CHAPTER ONE: INTRODUCTION

Introduction

Dating back to the early 1970s, concerns regarding the underrepresentation of women in math-related careers have sparked research in the area of sex differences in mathematics performance and participation (Hyde, Fennema, & Lamon, 1990a; Leahey & Guo, 2001, p. 5). Current sex difference findings revealed a mix of positive and negative mathematics achievement and effects (Ai, 2002; Rayya & Hamdi, 2001; Tsui, 2007). Sex difference studies, however, have been focused on exploring the causes of differences rather than on the differences themselves (Hyde et al., 1990a).

Biological age has been determined to be one contributing factor for sex difference in achievement. Changes in mathematics achievement in males and females have been observed to appear around 12 years of age (Hyde et al., 1990a). The data, however, has not provided sufficient evidence for generalization with regard to achievement differences between the sexes (Ai, 2002; Bornholt, 2000; Rayya & Hamdi, 2001; Tsui, 2007). The varying findings have been attributed to the confusion of research variables, methodologies, or lack of statistical capabilities at the time of study (Hyde et al., 1990a).

With time and improvement in technology (Reese, 2007), mathematics and sex difference research has begun to focus on a new mathematics teaching trend, one that invokes game play in mathematics classrooms. According to Lim, Nonis, & Hedberg (2006), “Students exposed to new technologies have grown accustomed to their presence in their daily lives” (Lim, Nonis, & Hedberg, 2006, p. 212). Prensky (2001a) has reported that teachers are, for the most part, “digital immigrants” and their philosophy of teaching and/or teaching methods must change to match their intended audience. Game play when learning mathematics has begun to be explored as a true potential for learning (Amory, 2007; Kafai, 2006; Ke & Grabowski, 2007; Sedighian & Sedighian, 1996).

Not all findings, however, have supported the use of educational video games in the classroom (Kafai, 2006). Negative perceptions with regard to video games have surfaced (Mubireek, 2003). Rice (2007) summarized the views of some stakeholders that video games are "mindless forms of activity and do not hold an affinity to strong instructional content (p. 252). Rice noted that some stakeholders have associated violence to video games but also acknowledged that many of the negative comments documented with regard to video game usage in the classroom have been made by those who had little to no game play exposure.

It has been presumed that as diffusion of technology with successive generations disappears, video game play and technology bias from stakeholders may naturally disappear (Provenzo, 2000; Rice, 2007). Nonetheless, Rice identified several barriers that can add to the overall negative perception. These included (a) game graphic quality, (b) lack of classroom time for game play, and (c) inadequate representations of learning objectives when deploying video games as a teaching mechanism. Rice also observed the "negative perceptions surrounding the term (gaming) itself," (p. 252) when speaking of in-class game play.

Within the results from a meta-analysis concerning instructional games conducted by Randel, Morris, Wetzel, and Whitehill (1992), only 22 of 67 educational game studies indentified showed favorable game acceptance over conventional instruction for classroom activities. When compared to traditional classroom teaching, no differences in improvement were found in 38 of the reviewed studies. Although Randel, Morris, Wetzel, and Whitehill

(1992) reported mixed findings with regard to educational games and learning, computer games were found to be specifically “effective in improving mathematics achievement scores” (p. 6).

Vogel et al., (2006a), in their extensive literature review, disagreed with the findings of Randel et al. (1992). Vogel et al. (2006) reported higher gains in both cognition and attitudes towards learning within the 32 studies used for inclusion. Sedighian and Sedighian (1996) also found positive results with regard to situating mathematics learning in a computer-based environment. Additionally, the findings of Randel et al. (1992) supported the use of computer games simply used as tutorials or for drill and practice events. This finding indicated significant improvement in mathematics achievement scores when games were used as an ancillary tool. Braun, Goupil, Giroux, and Chagnon (2001) indicated that “students’ academic performance is consistently positively related to video game use” (p. 539). Therefore, positive findings were simply more prevalent, thus, making video games a logical inclusion for usage as an in-class teaching tool.

Although video game play findings have been positive overall, Braun et al. (2001) indicated that boys had a stronger affinity for video game play than girls. This suggested a possible inequality in learning environment between the sexes. Another argument has surfaced, however, with regard to educational video game play or game type preference between the sexes. To be a successful teaching tool in the classroom, future learning must include a “desirable learning environment such that children can enter the environment with no or very little knowledge of the embedded mathematical concepts” (Sedig, 2008, p. 69) and without a need to overcome a learning curve or tool, such as an educational video game.

In an attempt to explain game play differences between the sexes, researchers specifically identified game content and design as a potential cause of the lack of perceived female game play results (Agosto, 2004; Hayes, 2005; Jones, 2005; Ray, 2004; Valenza, 1997). Hayes and Dickey (2006a) have suggested that the market needs to address female-only creations to capture the female audience. Entertainment Software Association (ESA) (2007), in its most recent report, *2007 Sales and Demographic Report*, suggested that females are gaming and countered Hayes' (2005) and Dickey's (2006a) stated need for more female-only game creations. ESA (2007) reported that 57% of those surveyed for the 2007 report agreed that there are more games specifically suited for women. However, only 38% of those surveyed were female game players.

A secondary game play barrier between the sexes has also been identified. Game designs that include violence, negative sex stereotypes, or the lack of social aspects inclusion have contributed to the lack of female game play (Agosto, 2004; Hayes, 2005; Jones, 2005; Ray, 2004; Valenza, 1997). Some researchers have suggested the identification of games as lacking in social aspects or inclusion. This has been attributed to the individual experience that game play presents. During game play, each participant approaches an activity, or game play, in a very unique, and individual manner (Gee, 2003). Whereas Braun et al. (2001) stated that verbal and social preferences are important attributes for girls when playing games, previous research has not addressed a preference for an individual experience. Video games offering only individual game play experience without socialization components have not been found to provide an attractive option or learning activity for girls. According to Damis-Paraboschi, Lafont, & Menaut (2005), "girls prefer verbal exchanges" (Damis-Paraboschi, Lafont, & Menaut, 2005, p. 180). If a game's design is missing social aspects, the game will likely not be preferred.

Current game designs must also remove sex and racial bias (Agosto, 2004; Mou, 2007) or content related to “hyper-sexualized stereotypes,” (Ray, 2004, p. 35) in order to attract female gamers. In 7th grade, females are subject to varying levels of maturity, and content including sex stereotypes or images could lead to embarrassment and create additional barriers to learning. The video game play experience then becomes a “turn-off” to the female sex (Valenza, 1997), thus, again, leading to an inequality in learning environment.

Lastly, the historic lack of exposure to video games and video game play by females can detract from a female’s ability to utilize prior knowledge (Reese, 2007). Activation of prior knowledge and the ability to relate to previous experience is necessary when learning. Jones (2005) has stated that the lack of video game play or exposure ultimately fails girls as they cannot “achieve goals, develop strategies and cooperate in groups while competing” (Jones, 2005, p. 2). Male familiarity with both the tool and the video gaming environment (Daviault, 2000) will continue to be seen as a disadvantage for females unless females are provided with a properly aligned tool for learning. If game designers keep to the current game development strategies of not including female preferred content, or if educators and administrators errantly implement video games without an understanding of video game play and preference between the sexes, males will continue to have a learning advantage in all areas of mathematics studies.

One cannot generalize regarding female mathematics achievement since disparities exist on a per topic basis between the sexes. Consequently, to state females learning mathematics using educational video games will fail is an overstated generalization. The barrier may not be the subject. It may be the game itself or the environment in which the video game is being played. Additionally, this study was conducted to examine sex difference regarding educational video game play and preference and to provide further empirical evidence with regard to achievement outcomes or motivation toward the subject when educational video game play is implemented in the classroom. If using educational video games to teach mathematics, female learning may suffer from one of several conditions: (a) the lack of socialization in video game play settings or content, (b) the inclusion of negative sex stereotypes in game design and content, or (c) the lack of previous video game play exposure and play.

Purpose of the Study

The purpose of this study was to determine if there was a difference between male and female 7th grade Mathematics 2 and Mathematics 2 Advanced students in (a) academic mathematics achievement, as measured by district (countywide) benchmark exams and (b) mathematics class motivation, as measured by Keller's Course Motivation Survey (1986) when using a video game suite as a teaching tool. The game suite contained single and multiple player components and was utilized in an open and social lab setting. Additionally, this study aimed to reveal sex differences in educational video game play and preferences by exploring both learning outcome results and game play activities. Particular attention was devoted to female perceptions and participation during the investigation.

Research Questions and Hypothesis

Within this study, the researcher defined the term *Sex Difference* to refer to biological difference, whereas, the term *Gender Difference* referred to societal interaction difference based upon sex of the individual. Therefore, this study made use of these terms as needed, but attempted to utilize the statement "between the sexes" where possible.

This study was conducted to answer five research questions. Six hypotheses were used in responding to the questions. Following are the research questions and the supporting hypotheses.

1. Are there differences in academic mathematics achievement scores between sexes when using an educational video game as an in-class tool or media?

   H_0Female mathematics achievement scores will not differ from male mathematics achievement scores statistically.

2. Are there differences in motivation scores between sexes when using an educational video game as an in-class tool or media?

   H_0Female motivation scores will not differ from male motivation scores statistically.

3. Does academic mathematics achievement score change when using an educational video game to learn algebra?

   H_0Pretest mathematics achievement scores will not differ from posttest mathematics achievement scores, statistically.

   H_0There is no interaction between mathematics achievement score change and gender.

4. Does motivation toward mathematics class change when using an educational video game to learn algebra?

   H_0Pretest mathematics achievement scores will not differ from posttest mathematics achievement scores, statistically.

   H_0There is no interaction between mathematics achievement score change and gender.

5. What are the observed differences in video game play environments by sex? (Qualitative Question)

Overview of Research Method

This study was conducted to examine a 7th-grade middle school class, in which teaching methods utilizing an educational video game as a supplemental teaching tool to in-class activities and curriculum were used. To test the a priori hypothesis, this study utilized an experimental design that included a mixed-method analysis.

The population for this study was comprised of a large urban Florida county middle school, specifically 7th graders. A purposeful sampling strategy obtained a sample of 60 consenting students and one consenting middle school teacher. The particular sample was situated within a larger macro sample. The purpose of this study narrowed the original sample from 327 students to 60 to include a group of students that mirrored the age group that has been noted as being unaffected by mathematics achievement score changes (Hyde, Fennema, Ryan, Frost, & Hopp, 1990b; Leahey & Guo, 2001).

The study took place over an 18-week middle school session or term and applied an educational video game as the treatment. The applied treatment included a suite of single and multi-player educational mathematics video games that addressed pre-algebra and algebra concepts designed in mission format. There were 20 missions; all aligned to both state and national mathematics standards. Appendix A provides an example of the curriculum alignment for Mission 2. The video game suite provided visual as well as verbal feedback given during play that was designed to engage students in the learning of algebra concepts. The treatment has been advertised by the vendor as providing an immersive 3-D video game and gaming world for learning.

The data analysis began at the end of an 18-week school term. Two types of measurement instruments (a) district (countywide) benchmark exams, measuring academic mathematics achievement, and (b) Keller's ARCS motivation survey, measuring mathematics class motivation, were used. The instruments were used to collect data with regard to academic mathematics learning outcomes because of in-class teaching and lab activities.

In addition to learning outcome and motivational data collection, the mixed-method analysis included observational and interview data to support quantitative findings made during the 18-week term. These additional instruments were intended to gather preference and performance data previously unreported through other data collection methods.

Overview of Hypothesized Conceptual Framework

The hypothesized conceptual framework in this study was used to (a) identify variables for investigation, (b) guide the design of this project's research, and (c) provide organization for the results and discussion of findings. Following are details of the study's hypothesized conceptual framework.

The Cultural Historical Activity Theory (CHAT) served as the basis for the hypothesized conceptual framework. CHAT permitted the examination of the relationships between subjects, objects, and community activity units that comprise a larger framework of a working system. CHAT, as it evolved, offers a framework for exploring the interactions on a minute level that are present within a human activity for the purpose of examining direct and indirect relationships between individuals and their environment (Barab, Barnett, Yamagata-Lynch, Squire, &

Keating, 2002; Engestrom, 1987; Fiedler, 2006). The identified units culminate in the achievement of the desired outcome for a particular activity.

For the purpose of this study, the researcher utilized a third generation version of Cultural Historical Activity Theory (CHAT) as a framework for the hypothesized conceptual framework. The selection of the CHAT third generation allowed the researcher to explore the "dynamic relations between subjects, artifacts, and mediating social structures," (Gros, 2007, p. 7) while operating within a networked activity system sharing *mathematics problems* as the object.

CHAT allowed the researcher to conduct a qualitative analysis to examine the connection, if any, between two systems that utilized an additional shared component, an educational video game, while measuring activity outcomes. CHAT places the "emphasis on how individuals transform objects in the environment and the activity systems that allow this transformation to become obvious" (Blunt, 2006, p. 42). This study sought to document the transformation of the object, *mathematics problems*, through a dual activity system exploration of (a) a mathematics lab activity, and (b) a game play activity.

The CHAT framework identified the additional shared component as a tool that mediated the relationship between the subject, s*tudents*, and the object, *mathematics problems*. Thus, not only was it important to document the transformation of the object but to measure meaningful outcomes. For this study, the meaningful outcomes were mathematics class motivation and academic achievement, since these items represent those closest to learning theory and national and state measurement benchmarks. Therefore, unique data collection instruments were used to measure each activity outcome. They included: (a) Keller's ARCS motivational survey that measures mathematics class motivation and (b) countywide benchmark examination scores that measure academic achievement.

This hypothesized conceptual framework was used to explore shared components between activity systems while using a complete framework to examine previously reported female video game play barriers. This framework also allowed the researcher to examine needs, preferences, and participatory feelings toward game play preference and environment between the sexes.

Significance of Study

This study was significant for several reasons. It represents a contribution to the literature concerning educational practice and theory. By examining mathematics academic achievement and sex difference and utilizing a third generation framework of Cultural Historical Activity Theory (CHAT), this framework allowed for the examination of shared objects in relation to each other. This study provided additional data concerning potential sex difference barriers and benefits with regard to game play preference, and social aspects of educational game play environments.

Although there have been several studies that have been focused on educational video game effects in K12 classrooms (Ke & Grabowski, 2007; Sedighian & Sedighian, 1996), none have been conducted to examine a commercial educational video game that demonstrates an alignment to current mathematics curriculum standards.

The greater significance of this study was in developing improved understanding of the benefits, consequences, or preferences for implementing an educational video game in a K12 classroom. The results were intended to provide valuable data to: (a) school administrators who need to make well-informed game selection decisions for educational learning, (b) educators who need to use best-practices for utilizing and implementing educational video games in a cooperative environment (Ke & Grabowski, 2007), and (c) instructional and game designers who must create activities and video games that allow students to “transfer their experiences to other game-like environments” (Jones & Kalinowski, 2007, p. 132).

CHAPTER TWO: LITERATURE REVIEW

The literature reviewed for the present study was related to mathematics and educational video game play. The review was conducted (a) to explore the relationships between these two topics to create a hypothesized conceptual framework for each of the variables under examination and (b) to establish a bridge between the literature about in-class educational video game play and current empirical findings with regard to sex differences and video game play. The review was intended to support the hypothesized theoretical approach used to examine the use of educational video games as a teaching medium in a mixed sex K-12 setting. The review of literature contains three main sections (a) Literature Review Method, (b) Empirical Findings, and (c) Hypothesized Conceptual Framework.

Section One: Literature Review Methodology

This subsection describes the systematic approach used to delineate and locate literature for inclusion in this study.

To be thorough, the researcher repeated the literature review performed in Dempsey, Rasmussen, and Lucassen's (1994) decade-long gaming research review and classification process. Appendix B contains a summary of the articles included in the review. The decision to repeat the Dempsey et al. literature review process supports the thoroughness found within their study, which best summarizes the literature reported prior to the millennia. Additionally, the 1994 review presented a genuine separation between gaming and simulations (Dempsey et al.), whereas, a majority of other reviews fell short in their attempt to define gaming (Pijls, Dekker, & van Hout-Wolters, 2003; Vogel, Greenwood-Ericksen, Cannon-Bowers, & Bowers, 2006b).

Gaming, therefore, as cited in Dempsey et al. “defined as any overt instructional or learning format that involves competition and is rule guided” (p. 3).

This literature reviewed for the present study included articles written between 2000 and 2008 and after the Dempsey et al. (1994) review period. These years represent the period of vast acceptance of gaming technology (Squire, 2004; Van Eck, 2006). The extensive meta-analyses completed by both Dempsey et al. and Leahey & Guo (2001) detailed two decades of empirical research and indicated that the field of mathematics analysis had changed at a fast pace. It was appropriate, therefore, to examine only those changes from the millennia to the present. Technology, in terms of usage (Prensky, 2001b) has taken on a new role. Digital Natives have become comfortable with using different tools and surroundings to achieve learning outcomes. Therefore, it was appropriate to review only the most current literature available to best identify results for generalization.

Dempsey et al. (1994) created their review based upon disparities and the lack of cohesiveness of findings. Due to the many disparities in terms, the researchers created a framework to organize their findings on gaming and educational effects. The 1994 findings revealed 91 sources after searching ERIC, PSYCHLIT, and MEDLINE in addition to the inclusion of applicable referenced citations. Only the keywords *Instructional Games* were examined in the Dempsey et al. 12-year review.

According to Dempsey et al. (1994), gaming articles have been divided into five areas. These areas include:

> (a) research; which predict/control, (b) theory; which provide explanation and examine[s] models for future research exploration, (c) review; which yield general overviews or give

> specific aspects of a product, (d) discussion; which contain no empirical findings, and (e) development; which contain production articles that speak to products in alpha testing or those that are ready for review (p. 4).

This literature review utilizes the above classification to complete a thorough synthesis of recent studies relating to sex/gender difference, mathematics achievement, and educational video game in-class usage. Table 1 delineates literature findings based upon the various keyword combinations used while searching EBSCO host, and the databases of MEDLINE, PSYCHINFO, PSYCHLIT, ACADEMIC SEARCH PRIMER, ERIC, and DISSERTATION ABSTRACTS available from PROQUEST.

Table 1.
Keyword Search 1 x 1 Matrix

Keyword	Educational Video Games	Instructional Games	Instructional Video Games	Learning	Math	Gender/Sex Differences
Educational Video Games	141	21	--	112	10	(gender) 10 (sex) 5
Instructional Games	21	126	139	151	12	8
Instructional Video Games	--	139	50	35	2 *	3
Learning	112	145	35	--	--	--
Math	10	12	2 *	--	--	540 **
Gender/Sex Differences	(gender) 10 (sex) 5	8	3	--	540 **	--
Gender	3 *	--	3 *	--	--	--
Videogames	3 *	--	3 *	--	--	--

(*) Denotes all duplicate results

(**) Denotes the overall findings, not reduced by addition keywords

As seen in Table 1, the keywords of *Sex/Gender Differences* AND *Mathematics* yielded a promising 540 articles for review. However, when including the terms *School* and *Student*, the search total reduced to 211 articles. Additionally, when examining *Sex/Gender Differences*, *Mathematics*, AND *Instructional Games*, the results produced only one article by Rayya and Hamdi (2001); whereas, when using only the keywords, *Instructional Video Games*, the results produced 50 articles for review. The application of the keyword *Videogames*, in a singular fashion, or used in combination with the keyword of *Gender*, reduced the findings to three.

Additionally, as seen in Table 2, the combination of the keywords *Educational Video Games*, *Learning*, and *Math*, reduced the overwhelming 540 articles to 10. However, when adding the keyword of *Sex/Gender,* there were no articles for review. In comparing the keywords of *Instructional Games* rather than *Educational Video Games*, both instances of combining *Sex/Gender Differences* and *Learning* produced 12 and 11 articles respectively. By including the keywords of *Sex Difference* rather than *Gender Differences*, the results yielded only one article.

Table 2.
Keyword Search 2 x 1 Matrix

Keywords	Math	Sex/Gender	Learning
Inst. Games Sex/Gender Difference	12	--	6* (sex) 1
Inst. Games Learning	11 (w/Sex&Gender) 2	6 * (sex) 1	--
Ed. Video Games Gender Difference	0	--	4 * (sex) 1
Ed. Video Games Learning	10 (w/Sex&Gender) 0	4 * (sex) 1	--

(*) Denotes all duplicate results

The terms *Gender Differences* and *Sex Differences* were used interchangeably within the literature (Braun et al., 2001; Downey & Vogt-Yuan, 2005; Leder, 1985). The same held true for the keywords *Video Games* and *Videogaming* (one word). Searches involving dissertations (interdisciplinary) published within the last 10 years produced the following Boolean results per keyword. (Please note: ( ) signifies the number of results per keyword.)

Topic results included: (a) *Educational Video Games AND Learning* (38), (b) *Instructional Games AND Learning* (10), (c) *Instructional Games AND Sex/Gender AND Mathematics* (1), (d) *Educational Video Games AND Sex/Gender AND Mathematics* (1), (e) *Educational Video Games AND Sex/Gender AND Learning* (1), (f) combined with *Mathematics* (None), or lastly, (g) *Instructional Games AND Sex/Gender AND Learning* (1), (h) combined with *Mathematics* (1 duplication). Additionally, if using EBSCO's visual representation feature, findings are classified by the following areas: (a) *educational games* (4), (b) *computer assisted instruction* (CAI) (2), (c) *teaching methods* (4), (d) *elementary education* (1), (e) *classroom learning activities* (1), (f) *general games* (3), (g) *elementary and secondary education* (2), and (h) *in-class mathematics instruction* (1).

Surprisingly, only three dissertations met all requested search criteria. However, the topics varied within these dissertations. They included the subjects of: (a) statistics and sex difference (Gambler, 2004), (b) ethnicity and reading achievement of grades three through five (Littin, 2001), and (c) motivation to use a computer and student beliefs toward mathematics and computers of ninth grade game-playing and learning strategies (Haynes, 1999). Thus, although these dissertations met all requested keyword searches, they were lacking as a unified topic of examination in terms of studies surrounding sex difference, educational game play preference and settings, motivation, and academic mathematics achievement.

After removing duplicates, 68 articles remained. Of these, only 17 articles and 3 dissertations contained or discussed topics related specifically to *Educational Video Games* and *Sex/Gender Differences*. It was these articles that were divided into five categories and are presented per the Dempsey et al. (1994) game literature classification. These findings are contained in Appendix B for further review. For each of the following topics discussed in the following sections of the literature review, a summation of the method and keyword search used to locate articles for discussion has been provided.

Section Two: Empirical Findings

Because of the varying empirical results found in the literature regarding sex difference, academic mathematics achievement, and educational video game play difference, the researcher has attempted to frame the findings as they relate to each other. Section Two is therefore divided into the following subheadings (a) gaming definitions; (b) the history of sex difference research in mathematics; (c) game play for learning, and (d) girl gaming habits, barriers, and missing literature.

Gaming Definitions

The keyword terms for this portion of the discussion include (a) *Video Games,* both console and computer, (b) *Educational Video Games,* (c) *Instructional Video Games,* (d) *Digital Games,* and (e) *Simulations.* No profound explanation was found within the literature to explain the interchangeable usage of the terms *Instructional* and *Educational* video games; however, a clear distinction was made between both topics and that of a commercial game versus an educational game. The primary difference between categories falls in the realm of entertainment versus education (Van Eck, 2006). Although no published literature provided a distinction between *commercial* and *educational* video games, other than an assumed monetary connotation, the specific definition used in this study defined commercial games as not aligned to course objectives or state and national educational standards.

Rarely have the terms *Digital Games* and *Simulations* been mentioned within the literature when employing a keyword search that includes the terms *Educational Video Games* AND *Sex/Gender Difference*(s) (Bonanno & Kommers, 2008; Villano, 2008). It is likely that the term *Digital Game* is a misnomer as it describes the same types of games found in studies located using the terms *Educational* and *Instructional* video games. Some consider simulations more efficient than video games, since they require the user to perform a specific task under the specific restraints without waver (Vogel et al., 2006b). However, simulations have been identified as being more expensive to employ (Vogel et al., 2006b), and commercial in nature (Squire, 2004). Teachers in academic settings have not typically used simulations since time and money are precious commodities. Although simulation discussions have decreased in modern literature, increases in game sufficiency statements with regard to learning have increased (Halttunen & Sormunen, 2000; Squire, 2004).

Given the varying terms used to describe electronic video games, it was important in performing a literature review to use succinct keywords searches. The only keyword combination used within this dissertation to reveal educational video game usage in the classroom was *Educational Video Games.* Additionally, the only acceptable definition for an educational video game with this dissertation was an electronic video game installed on a PC or MAC, whether through download or via CD-ROM. The keyword combination of *Educational Video Game* also embodied the notion of a game created specifically designed for educational use and used as an in-class teaching tool to facilitate achievement of course/curriculum objectives or goals.

The History of Difference between the Sexes in Mathematics Performance Research

Volumes of information surround the topic of sex/gender difference concerning mathematics. This field clearly has had many unique studies, each powerful in their own right. However, within the combined realm of sex difference, achievement, mathematics, and gaming, only 17 articles yielded additional references for review. However, these 17 articles did not present a clear summation of topic. To build a logical connection between sex difference, academic mathematics achievement, and educational video games usage, it was necessary to complete a thorough literature examination. There has been overwhelming research support for three main overarching topics that create an association between these areas: (a) mathematics learning by category, (b) sex difference within the learning of mathematics, and (c) game play techniques for the learning of mathematics.

The need for mathematics research examining sex difference dates back to the early 1970s when concerns arose regarding the underrepresentation of women in math-related careers. Researchers observed that no women "have received the Fields Gold Medal for outstanding achievements in mathematics since its inception in 1936," (Leahey & Guo, 2001, p. 714). Missing female associates in the work force led researchers to believe the issue began in the classroom. This sparked research on disparities in mathematics performance and participation research between the sexes (Hyde et al., 1990a; Leahey & Guo, 2001). Researchers devoted their effort to discovering additional reasons for such difference, but contradiction of results prevailed (Ai, 2002; Rayya & Hamdi, 2001; Tsui, 2007). Hyde, Fennema, and Lamon (1990a) embarked upon a meta-analysis over a 20-year period to clarify the disparity of results surrounding sex difference and mathematics learning.

Many of the studies identified by Hyde, Fennema, and Lamon (1990a) contributed to the overall field of mathematics research and aided the advancement of mathematics sex difference studies over time (Lim et al., 2006). The author of these seminal studies included (a) Benbow and Stanley (1980), (b) Eccles (1987), (c) Siegel, Galassi, and Ware (1985), (d) Fennema and Peterson (1985), and (e) Fennema-Sherman (1976). Although Hyde, Fennema, and Lamon (1990a) thoroughly discussed these seminal studies within their meta-analysis, varying topics existed that simply compared sex difference and mathematics. The body of research examined within the meta-analysis did not present a unified goal for examination as it included such topics as (a) a gifted students study, (b) a value expectation model (Fennema & Peterson, 1985), and (c) a social learning study examining mathematics performance by mathematics aptitude and anxiety (Hyde et al., 1990b). Nonetheless, all findings did emphasize emotion (Frenzel, Pekrun, & Goetz, 2007) and attitude as contributing factors of sex difference in mathematics performance within each unique area of interest (Hyde et al., 1990b).

Hyde, Fennema, and Lamon (1990a) found only a slight, and not an exaggerated, sex difference with regard to academic mathematics achievement as first reported (Hyde et al., 1990b). Hyde, Fennema, and Lamon (1990a) blamed the disparity on the lack of statistical analysis at the time of study completion (Hyde et al., 1990a). However, one assumption at the onset of each study was that sex difference was a preexisting condition (Hyde et al., 1990b). No attempt was made to detect difference in the early studies. Rather, the focus was on investigating the cause. A unified position indicated sex difference in mathematics achievement starts to appear around 12 years of age (Hyde et al., 1990a).

Hyde, Fennema, and Lamon (1990a) believed Fennema-Sherman's 1976 study was the, "most prominent in the literature on mathematics attitude and affect" (Hyde et al., 1990b, p. 302). At the time of the present study, the Fennema-Sherman study remains undisputed. To revisit Fennema-Sherman's 1976 study during meta-analysis, Hyde, Fennema, and Lamon (1990a) sought to expand their understanding of the reasons for identified differences.

Overall, the analysis indicated boys had more positive attitudes towards mathematics. In all other areas of conceptual mathematics understanding, sex difference affect was small (Hyde et al., 1990b). Hyde, Fennema, and Lamon (1990a) also found there was a "glaring omission" (Hyde et al., 1990b, p. 311) of ethnicity research. Additionally, researchers confused the variables affect and attitude, and, therefore, errantly described research outcomes based upon the incorrect definitions (Hyde et al., 1990b). Sex difference in mathematics performance was slight at best (Hyde et al., 1990a). Hyde, Fennema, and Lamon (1990a) confirmed a mix of both positive and negative results which did not lead to a generalization that males outperformed females in mathematics achievement.

At the time of the present study, 211 articles were found that focused on sex difference, mathematics, and students in grades K-12 between 2000 and 2008. One staple article revealed another meta-analysis looking to address sex difference disparities found in previous decades. Leahey and Guo (2001) presented a modern day meta-analysis mirroring the Hyde, Fennema, and Lamon (1990a) approach. The Leahey and Guo stated purpose was to have "adjudicated conflicting results about the instigation of male advantage, stating reasons of limited research designs and samples" (p. 715). Unlike Hyde, Fennema, and Lamon (1990a), Leahey and Guo blamed design of studies rather than availability of technology resources for the conflicting results of research on sex difference.

Leahey and Guo's (2001) data from the National Longitudinal Survey of Yount (NLSY) yielded a sample of 6,253 students for their review. Findings once again exposed varying results. Girls scored higher on average than their male counterparts in both areas of reasoning and overall mathematics indicators until age 11. However, Leahey and Guo noted only a .5 standard deviation score difference favoring males after age 12, whereas, reasoning appeared equal between the sexes. Leahey and Guo agreed that disparity between the sexes, if found within results, existed for middle school aged students. Students 12 years of age represent the age group in which score change between the sexes existed.

Similar studies between 2000 and 2008 examined the same variables found in previous decades of research; however, there was an increase in the range of educational levels examined (Akinleye, 2005; Alkhateeb & Jumaa, 2002; Brunner, Krauss, & Kunter, 2008). Males again presented advantages in several areas of mathematics studies of (a) engendered cooperative learning environments (Hernandez Gardunio, 2001), (b) spatial relations (Kaufmann, Steinbugl, Dunser, & Gluck, 2005), and (c) specific mathematical abilities rather than overall mathematical concepts (Brunner et al., 2008). However, disagreement about sex difference within particular mathematics topics for learning have resulted in convoluted findings of modern day research (Ding, Song, & Richardson, 2006). Disparity has appeared to be the driving force for research but has also caused a shift in focus toward self-concept research (Hergovich, Sirsch, & Felinger, 2004; Ireson, Hallam, & Plewis, 2001).

Although of sex difference in the learning of mathematics has been reported by some researchers, Hyde, Fennema, and Lamon (1990a) found the cause to be the variety of measurement terms. Additionally, when empirical findings were legitimatized, the difference was noted as slight (Hyde et al., 1990a). In summary, disparities among the sexes have not promoted generalization, and findings have been limited to those determined on a per study basis (Bornholt, 2000). One positive outcome resulted from the review of historic findings; a unified mathematics teaching trend has emerged regarding the positive value for learning of game play in the classroom.

Game Play for Learning

In this section educational mathematics game play and the articles found that added to the overall literature review results are discussed. The keywords of *Educational/Instructional Games* were added within the search. These terms allowed for the inclusion of a category of in-class games, educational or instructional, which have been prevalent since the 1990s (Mubireek, 2003). Although the keywords *Educational/Instructional Games* yielded a minimal number of articles to add to the overall review, the articles found allowed for the inclusion of other individual topics mirroring this study's purpose such as: (a) sex difference, (b) education, (c) mathematics, and (d) video game usage. The keywords, *Game Play*, did produce a number of articles. Without the inclusion of the terms *Education* or *Instruction,* the focus was beyond the scope of this study. The articles using *Game Play* only were excluded from review unless they included sex difference results.

Video game systems have been growing in popularity since the early 1970s (Eglesz, Fekete, Kiss, & Izso, 2005; Winn, 2002). During such time, video games have become a permanent source of entertainment in all facets of life. Researchers have suggested that educational video games provide value, but a teacher's beliefs system about video game play may ultimately effect video game implementation and success in the classroom (Ertmer, 2005). Conversely, "instructional games can be as engaging as action games, but we tend to regard the zeal that these games engender as less alarming" (Garris, Ahlers, & Driskell, 2002, p. 441). Nonetheless, some games are simply quite instructive and enlightening (Vogel, 2007). With so many different elements for inspection, it has not been surprising that there has been a growing interest in educational video game usage in the classroom (Mitchell & Savill-Smith, 2004; Vogel). Regardless of the controversy as to their value, video games had gained a solid foothold in the market and popular culture by the beginning of the 21st century (Entertainment Software Association (ESA), 2007; Garris et al.)

There has been a trend toward a more active learner role in which students learn by doing, but a move away from the teacher-directed model of instruction (Garris et al., 2002; Niederhauser & Stoddart, 2001). Similarly, learning has changed from being able to recall information to being able to find and use information (Simon, 2000). "New interactive technologies provided opportunities to create learning environments that actively involve students in problem solving" (Ncube, 2007, p. 5). Additionally, "empirical evidence exists [indicating] games can be effective tools for enhancing learning and understanding of complex subject matter" (Ricci, Salas, & Cannon-Bowers as cited in, Ke, 2008, p. 1609).

Game play in the realm of mathematics has been studied to determine if there is a true potential for learning (Amory, 2007; Kafai, 2006; Ke & Grabowski, 2007; Sedighian & Sedighian, 1996). Not all findings, however, have supported the use of educational video games in the classroom (Kafai, 2006), and some negative perceptions with regard to video games have surfaced (Mubireek, 2003). Rice (2007) summarized the perceptions of some educational stakeholders who considered video games to be “mindless forms of activity and do not hold an affinity to strong instructional content” (p. 252). He further indicated that some stakeholders held the belief that games have a general association with violence. Rice (2007) also noted that many of the negative perceptions could be attributed to those who had little to no game play exposure.

It has been expressed that as diffusion of technology with successive generations has disappeared, video game play and technology bias from stakeholders may naturally disappear (Provenzo, 2000; Rice, 2007). Nonetheless, Rice identified several additional barriers that aid to the overall negative perceptions of educational video game play in the classroom. These negative perceptions include (a) game graphic quality, (b) lack of classroom time for game play, and (c) inadequate representations of learning objectives when deploying video games as teaching mechanisms. Rice further states “negative perceptions [surround] the term (gaming) itself” (p. 252).

Further studies have fortified the findings of Rice (2007) and added additional elements of complexity when implementing educational video games in K-12 classrooms. The Randel, Morris, Wetzel, and Whitehill (1992) meta-analysis concerning instructional game utilization found only 22 of 67 articles that favored game play over conventional instruction. Of the original 67 articles, only 38 indicated no difference in improvement compared to traditional classroom teaching. Although Randel, Morris, Wetzel, and Whitehill (1992) reported mixed-findings with regard to educational games and learning, computer games are found to be specifically “effective in improving mathematics achievements scores” (p. 6).

Commercial games were also analyzed within the overall review. Squire (2004) believed (a) that empirical evidence was sorely lacking prior to the millennia with regard to commercial video game utilization in the classroom, (b) that new research would advance video game play acceptance in the classroom, and (c) that commercial success of video games should be equally supportive for learning. He also believed that researchers needed to understand gaming habits in order to alleviate learning barriers and provide educators with a path for successful video game implementation in the classroom. In order to conduct his decade long review of commercial games and test Civilization III in the classroom, Squire created his own rubric for evaluation.

Vogel et al. (2006a) disagreed somewhat with Randel et al. (1992) with regard to the value of computer games. Vogel et al. (2006a) reported higher gains in both cognition and attitudes for learning within a review of 32 studies. Randel et al. (1992) supported the use of computer games simply when used as tutorials or for drill and practice events. They found significant improvement in mathematics achievement scores all around when used in this fashion.

Sedighian & Sedighian (1996) implemented a computer-based mathematical game (CBMG) environment within 6th and 7th grade geometry classes. Their findings were positive with regard to situating mathematics learning in a computer-based environment but could not be generalized because of the uniqueness of the students (gifted). The researchers did not discuss sex difference as a variable under study and only focus upon the visual aspects of learning geometry in comparison to other mathematics topics such as algebra.

Another positive benefit for the use of educational video games in the classroom was “flow” or “flow state.” Flow state identifies the level of concentration witnessed that gamers achieve during game play. Csikszentmihalyi (as cited in Reese, 2007) stated that a common immersion when playing video games, coined as flow or flow state, is “characterized by intense concentration and excitement” (Reese, 2007, p. 283). There are two types of flow identified by Reese. One form of flow evokes prior knowledge through reflection, whereas, the other guides self control. Flow in game play yields future implications regarding “structure mapping theory of analogical reasoning for designing educational games (Reese, 2007, p. 285). Researchers have considered flow as a highly positive finding.

Braun, Goupil, Giroux, and Chagon (2001) summarized game play for learning best when they wrote “students’ academic performance is consistently positively related to video game use” (Braun et al., 2001, p. 539). The result of positive findings has been the acceptance of video games in mathematics curricula as a logical teaching media in which “electronic game technologies can prepare novice learners for future learning of complex concepts” (Reese, 2007, p. 1). The heightened concerns for the conjoining of mathematics learning and educational video game play, has come to be unfounded. As “students are exposed to new technologies and have grown accustomed to their presence in their daily lives” (Lim et al., 2006, p. 212), learning and gaming discussions have quieted. Gaming studies have evolved to focus on motivation, situational learning (Ke & Grabowski, 2007), and engendered game design (Kafai, 2006).

Girl Gaming Habits, Barriers, and Missing Literature

Literature for review was available in volumes regarding sex differences. This was evidenced in (a) the 28-year review of gaming and instruction by Randel et al. (1992), (b) the 12-year review of gaming and literature by Dempsey et al. (1994), and (c) Squire’s (2004) extensive review of commercial video games as teaching tools. A further important area for review was the analysis of game play habits and barriers for sex differences. Therefore, within this section, the keywords of *Sex/Gender* and *Video* were added to the overall review of literature. With the addition of keywords, *Sex/Gender* and *Video,* the literature results narrowed greatly. Naming disparities within the gaming literature for gender versus sex and gaming versus video gaming were found; and several studies supported female game play but were missing the inclusion of mathematics or educational video game. However, the results prove invaluable to this review.

Steinmayr & Spinath (2008) argued that sex difference results were inconclusive with regard to educational video game usage for learning. The inconsistency of results was attributed to poorly designed research characterized by (a) the broad spectrum of ill-defined variables examined and (b) the use of poorly structured game play settings. Conversely, Braun et al. (2001) narrowed their research to examine the affinity for gaming between the sexes. They found boys have a stronger affinity for video game play than girls do. Ray (2004) found that girls did in fact play video games.

The literature review method for Girl Gaming Barriers was expanded further by adding the keywords of *Games for Women.* The use of *Girl* and *Female* produced similar results; however, this study utilized the keyword *Girl* throughout this discussion as primary due to the age of sample discussed. This expansion added 30 additional articles for inclusion. However, the terms *Educational Games*, *Women's Studies*, *Games*, *Instructional Material*, *Sex Discrimination*, and *Sex Roles,* in various combinations, produced negative results. Therefore, only 15 new articles were added using the keyword combinations of *Game Design* and *Girls*, but only five items belong to peer-reviewed sources. However, the keywords of *Game Design* used in conjunction with the keyword *Women* produced zero results, the terms *Video Games* and *Girls* offered five promising results. At this point, only 26 articles remained in which sex differences in video gaming were discussed. The keywords *Gender* and *Sex Difference* were used interchangeably. In the reviewing of the remaining 26 articles, the additional keywords *Engendered Instructional Design* were identified and included. Engendered instructional design refers to a design with a sex orientation in mind. Further review revealed differences of opinion by designers with some believing educational video game play and games should be designed specifically for girls/women (Cassell & Jenkins, 1998; Dickey, 2005, 2006b).

The literature presents a unified theme emerged across findings with regard to sex difference relative to preference and performance by females when using educational video games. Barriers to females' learning were explained as: (a) a lack of previous video game play exposure, (b) a lack of previous socialization requiring a specific need in video game designs, (c) a need for girl-only game design and development, (d) hyper-sexualized gaming content which detracts from learning, and (e) the historically negative concerns surrounding video game violence (Lynn, Raphael, Olefsky, & Bachen, 2003).

Socialization difference (Hayes, 2005) in males and females has been attributed to a lack of action efficiency when playing team sports (Damis-Paraboschi et al., 2005). Hayes stated this lack of socialization begins at an early age when males are allowed to explore their surroundings in a less restrictive way. This difference causes "girls to prefer verbal exchanges whereas boys score higher in physical involvement" (Damis-Paraboschi et al., 2005, p. 180). Verbal and social preferences are also important attributes for females when playing games (Braun et al., 2001). Girls, however, reported preferences for wanting to "operate computers in groups" (Braun et al., 2001, p. 541) rather than alone at home, again due to formed socialization patterns. According to

Damis-Paraboschi et al., this interaction between students allows for cognitive development and should be encouraged. A collaborative game play or learning environment allows females to play to their strengths of communication and yield more of a social aspect to a game play environment (DiPietro, Ferdig, Boyer, & Black, 2007).

Social pressures have been viewed as an additional disadvantage for females in learning (Leder, 1985). As girls mature, they tend to socialize, and pay less attention to technology (Li & Atkins, 2004; Mann, 1994). Girls may not be prepared to learn when computers and educational video games are employed in the classroom (Agosto, 2004). Ultimately, girls fail due to a lack of prior exposure. They often cannot “achieve goals, develop strategies and cooperate in groups while competing” (Jones, 2005). Multiplayer games require this type of negotiation to be successful at game play.

Though it has been indicated that girls do play video games (Ray, 2004), certain gaming aspects such as violence and negative gender stereotypes have hindered the game play environment (Agosto, 2004; Hayes, 2005; Jones, 2005; Ray, 2004; Valenza, 1997). Outside the realm of video game play, researchers have found that conversation and socialization are of high importance to the present generation of children in the forms of blogs and social networking (Hsi, 2007). Educational video game designers who include specific preferences unique to each sex allow students to develop the ability to “transfer their experiences to other game-like environments,” (Jones & Kalinowski, 2007, p. 132). Ultimately, females can improve their skills. The concept of engendered game design was, thus, further supported in the literature review (Castell & Jenson, 2004; Dickey, 2006b; Hayes, 2005).

Game content and design has been characterized as containing sex and racial bias (Agosto, 2004; Mou, 2007) or “hypersexualized stereotypes” (Ray, 2004, p. 35). Each present barriers to female video game play, and simply “turn-off” females (Valenza, 1997). Mubireek (2003) examined preference, performance, and motivation using three engendered educational mathematics video games at the elementary school level. Mubireek’s (2003) findings supported the possibility for sex-oriented game design as a positive mechanism. Conversely, not all of Mubireek’s (2003) findings related specifically to the sex-oriented game design, but were also focused on the point totaling system designed within each game.

Sex-oriented versus sex-neutral research such as Mubireek’s (2003) has been useful in identifying gaming attributes needed to improve game play for elementary school females, and other studies have focused on high school students. The middle school age has been neglected, however. This is the time period when changes in mathematics learning are identifiable and make it easier to ascertain educational video game effects versus learning differences between the sexes (Hyde et al., 1990a). Typically games have been “designed by males and made for use by other males” (Mubireek, 2003, p. 8). The establishment of companies such as Purple Moon, Her Interactive, Girl Games and Girl Tech have been helpful in protecting girls’ gaming interests and combating disparities in game development (Daviault, 2000).

Researchers have argued that creating engendered or androgynous games hinders the overall socialization process (Cassell & Jenkins, 1998). This view ushers in the need to create sex-neutral games that appeal to all (Subrahmanyam & Greenfield, 1998). However, spatial skills researchers found disparities among the sexes in that researchers could not recruit female game players, or if they did, discovered a lack of ability of girls to solve gaming aspects of the study (De Lisi & Wolford, 2002; Subrahmanyam & Greenfield, 1998). In some rare examples using current video games, girls appeared “relieved when they finished” (Subrahmanyam & Greenfield, 1998, p. 47). Researchers have posited that if designers keep to the current course of educational video game design strategies, boys will continue to have an advantage when utilizing educational video games in the classroom due to their familiarity with both the tool and the video gaming environment (Daviault, 2000).

There were other positive findings for game play between the sexes and the identification of girl gaming habits. Studies were centered on game environments examining (a) team sports while playing hockey (Goodman, Bradley, Paras, Williamson, & Bizzochi, 2006), and (b) a scripted learning course examining vocational job placement training (Hamalainen, 2008). Although neither study examined the use of electronic video games, findings supported game “play or making (designing) a game… [provide] a deep sense of engagement” (Kafai, 2006). Oddly, commercial games supported by the female audience, other than Where in the World is Carmen San Diego, were not reviewed (Kafai, 2006). Amory (2007) attempted to include commercial games when examining a sample comprised of 50% female participants. His discussion supported female game play and identified positive gaming habits for examination, but a mathematical focus was missing from the discussion.

Although rare in the literature, a simulation study conducted by Ke & Grabowski (2007) relayed positive findings toward social game play. Ke and Grabowski examined sixth graders within a cooperative environment utilizing Teams-Games-Tournament (TGT) without the use of electronic games. Researchers found “neither significant main effects of gender nor evident interaction effects between the treatment and gender on mathematics performance” (Ke &

Grabowski, 2007, p. 257) showing no barrier for female game play. Although, the learning environment was important within the present study's overall results, Ke and Grabowski reported only on those children identified as socio-economically disadvantaged (Ke & Grabowski, 2007) and thus, generalization was somewhat limited.

One last area of concern, female video game exposure, was reviewed. According to Reese (2007), female lack of exposure to video gaming transversely detracts from female ability to create prior knowledge. Researchers believe future learning must include a "desirable learning environment such that children can enter the environment with no or very little knowledge of the embedded mathematical concepts" (Sedig, 2008, p. 69). Females should enter a classroom without a need to overcome a learning curve or tool; activation of prior knowledge and the ability to relate to previous experience is necessary when learning. This relation is considered "a primary event of instruction" (Reese, 2007, p. 294). Without it, learning may be lost. Additionally, if game play becomes too challenging and there is no prior knowledge on which to rely, children will leave the activity feeling hopeless, give up and quit the experience (Vogel et al., 2006b). Motivation of play will be affected and needs examination.

Developing a good educational video game system is not enough for educators to believe in these systems. Educators know educational video games require appropriate pedagogical integration. This integration requires collaboration of educator with the educational video game (Niederhauser & Stoddart, 2001). This process becomes more than just knowledge of the game and teaching. Once the game's purpose is accepted, it is easy to maximize the potential of the game to be an effective instructional tool no matter what preconceived notion exists.

Summary

Whether through meta-analysis or the literature review presented by both Lim (2006) and Hyde, Fennema, and Lamon (1990a) and Dempsey, Rasmussen, & Lucassen (1994), respectively, all literature reviewed contained discussion of sex difference, it was concurred that sex difference exists. However, these differences were on a per topic basis. Video game play for the learning of mathematics also posited positive effects (DiPietro et al., 2007).

Literature reviewed related to game play and mathematics studies indicated there was real potential for learning when combined (Amory, 2007; Kafai, 2006). However, missing in the literature review was the conjoined discussion of these two topics with an analysis of sex achievement, motivation, and difference at a middle school level when using an educational video game to learn mathematics.

Section Three: Hypothesized Conceptual Framework

The hypothesized conceptual framework used to identify and examine the variables found during the review of literature is discussed in this section. Presented are the components of Cultural Historical Activity Theory (CHAT) that served as the foundation for the framework.

As seen in Figure 1, the components under study within the CHAT framework allowed the researcher to examine the relationships between subjects, objects, and community units of an activity that creates a working system. CHAT, as it evolved, offered a natural framework for exploring the smallest interactions present within a human activity. CHAT also provided a mechanism for examining the direct and indirect relationship between individuals and their environment (Barab et al., 2002; Engestrom, 1987; Fiedler, 2006).

Figure 1 further outlines the basic CHAT components of this theory's framework, which includes (a) rules, (b) subject, (c) community, (d) objects, (e) division of labor, and (f) instruments, sometimes referred to as tools or artifacts. The identified units culminate in the achievement of the desired outcome for a particular activity; Figure 1 refers to the outcome as Learning Outcome.

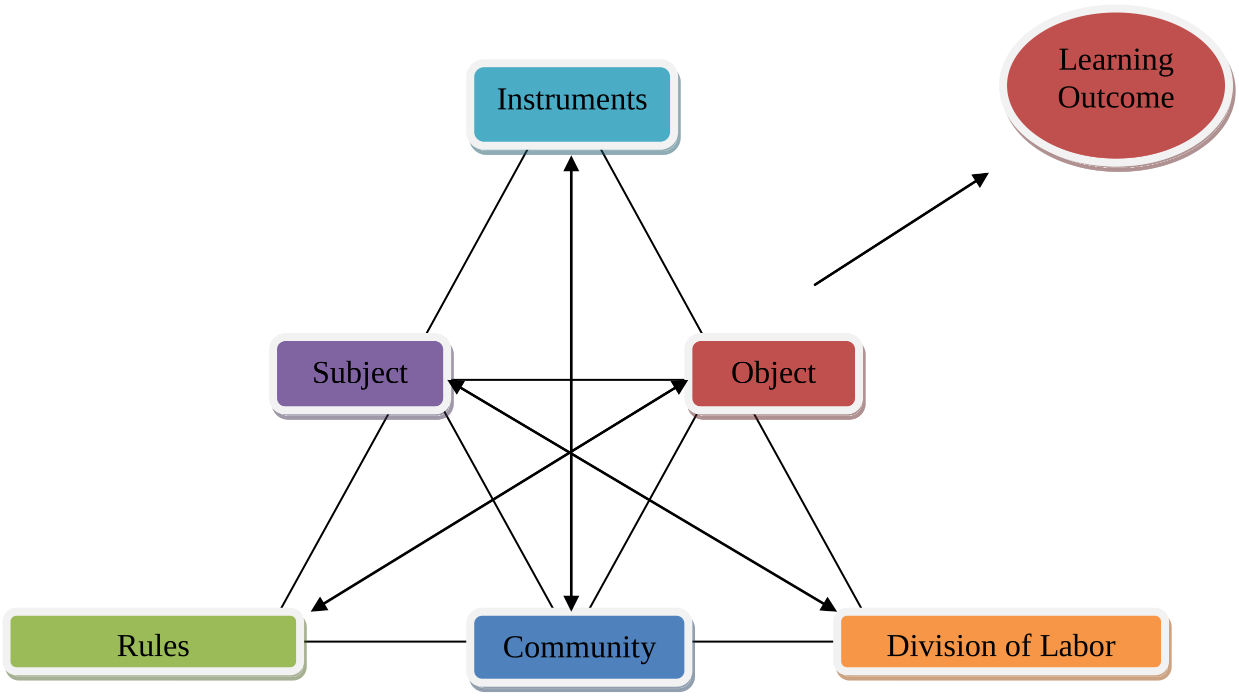

Figure 1. Cultural-Historical Activity Theory (CHAT) Construct

Although Figure 1 may depict an activity in a hierarchy of order and control due to its pyramid design, no one relation is superior to the other in an activity system. Participants use tools in the environment and create a holistic system of activity (Barab et al., 2002).

CHAT History

CHAT history begins with Vygotsky. Vygotsky studied the social realm of psychology and focused upon the theory of signs (Craighead & Nemeroff, 2001). Vygotsky used his work in the area of childhood speech development and social interaction to develop Social Learning Theory. Vygotsky (1978) stated the most significant moment in the course of intellectual development occurred when speech and practical activity converged. Historically, Social Learning Theory was used by Vygotsky to identify his personal socialist concerns in the 1920s and 1930s. Vygotsky examined the person in relation to the current socialist culture (Leonard, 2002) during the time of creation. Vygotsky’s views were held in stark contrast to those of Piaget (Simply Psychology, n.d.). Vygotsky believed play contained a fundamental social aspect needed for cognition (Kearsley, 1994). Vygotsky (1978), in his research, also indicated that game play has an enormous potential to influence children. Therefore, a practical child-like activity, such as game play, allows an individual to build meaning for the activity as they rely upon an interpersonal level of understanding. Speech used during interpersonal communication activities helps to connect the meaning constructed during the activity with the interpersonal world of the learner (Vygotsky, 1978). Thus, Social Learning Theory is born.

Vygotsky's work on the outer realm of his Social Learning Theory entitled Zone of Proximal Development was most notable. Within this theory, Vygotsky posited that the environment for the mind during learning was in the mode in which a person was given or solicited help from another (Craighead & Nemeroff, 2001). “Learning occurs within a social context, and that interaction between learners and their peers is a necessary part of the learning process” (Learning-Theories.com, 2007, p. 1). As seen in Figure 2, people begin with a limited knowledge of task and through interaction with a more skilled person, or mentor, individuals are able to expand their own skill set (Simply Psychology, n.d.). During interaction, scaffolding takes place. According to Leonard (2002), expansion of social circles increases one's true potential.

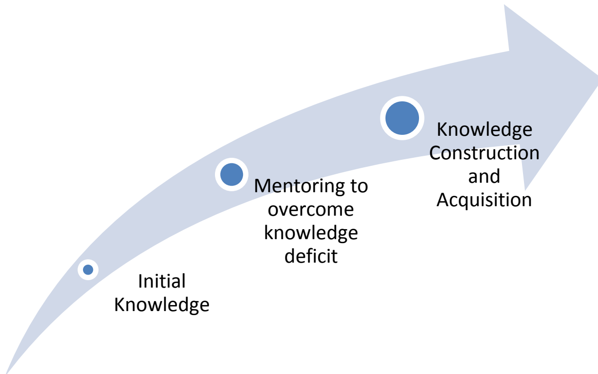

Figure 2. Zone of Proximal Development

Vygotsky (1978) further defined one's Zone of Proximal Development as "the distance between the actual developmental level as determined through problem-solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers," (p. 86). It was during the expansion of this belief in which artifact-mediated and object-oriented action was born. Vygotsky, however, believed "a human individual never reacts directly to environment" (Center for Activity Theory and Development Work Research, 2004, p. 1).

Leont'ev, a fellow Vygotsky colleague, expanded Vygotsky's artifact-meditation and object-orientation to include the examination of an activity, both collectively and individually. Leont'ev inclusion of social relations and tool mediation to interact with the environment was the second generation of Vygotsky's original mediating artifact theory. Leont'ev's version was the CHAT framework seen in literature today (Center for Activity Theory and Development Work Research, 2004). Figure 3 visually presents CHAT's evolution.

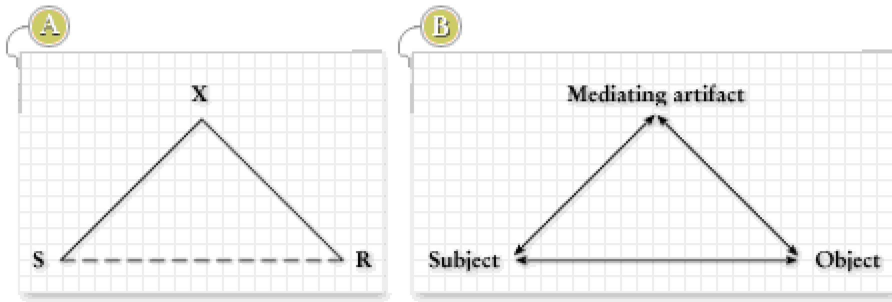

Figure 3. 1st and 2nd Generation Cultural Historical Activity Theory

In 1987, Engeström's (1987) demonstrated how CHAT could be used to study a human activity system (Center for Activity Theory and Development Work Research, 2004). Figure 1 additionally represents this current application of CHAT.

CHAT Components

CHAT's framework offers a natural foundation for exploring the smallest interactions present within a human activity in order to examine the direct and indirect relationship between individuals and their environment (Barab et al., 2002; Engestrom, 1987; Fiedler, 2006). Additionally, the hypothesized conceptual framework provided a method for organizing the present study and assisted in structuring of the resulting discussion, which follows in Chapter Four.

The unified relationship between units and environment creates an intentional system (Fiedler, 2006). As previously seen in Figure 1, CHAT presents each unit as it dynamically relates to the other within a formal system. The largest triangle visually represents the relationship between subject, object, and community as each mediates with a secondary component. The formation of a relational triangle also embodies Vygotsky's original artifact-mediated and object-oriented action theory. Subjects represent the group or individual under examination, whereas, the object is the item that will be transformed by the activity system

(Center for Activity Theory and Development Work Research, 2004). The object also "carries the motive, goal, or purpose for the activity" (Fiedler, 2006, p. 56). Community simply represents the community in which the activity is taking place, whether a classroom or a city.

The secondary set of components, instruments (tools/artifacts), rules, and division of labor, represent the interactions or mitigations between each of the primary units. The secondary components respectively represent an intersection between each primary unit and create junctures with that of the primary components. Instruments or tools, which can be mental or physical units, represent the interaction between subject and object. Rules, or governing conditions, represent the interaction between subject and community. Lastly, division of labor, which describes the within and between community interactions, represents the interaction between community and object. Conceptualized by Engeström (1987) as cited in Blunt (2006), CHAT places an "emphasis on how individuals transform objects in the environment and the activity systems that allow this transformation to become obvious" (p. 42).

CHAT Tensions and Networked Activities

As within in any formal system, tensions exist, but CHAT welcomes, and actually, relies upon internal tensions related to each unit in order to declare that a system is functioning (Barab et al., 2002; Fiedler, 2006). These named tensions mirror the above-identified activity units and primary and secondary tensions. A third level of tension is called a tertiary tension which is found examining an advanced form of the same activity (Fiedler, 2006). Lastly, CHAT presents extraneous or quaternary tensions. These are tensions created by external expectations that place extreme demands upon a unit (Fiedler, 2006). An example of such tension is a requirement to achieve, in a very short timeframe, an A+ grade in a school district previously identified as F-rated. Such an impossible request directly affects related units in the system and in extreme cases causes failure of the system.

Within an activity system, the potential also exists for networking or linking of activities when utilizing the same unit of analysis between systems (Barab et al., 2002; Center for Activity Theory and Development Work Research, 2004), as seen in Figure 4. Each networked item brings the same tension to the marriage, and thus, a system remains intact. Conversely, if an activity system has quaternary tensions that are unmanaged, the marriage experiences the same negative tension.

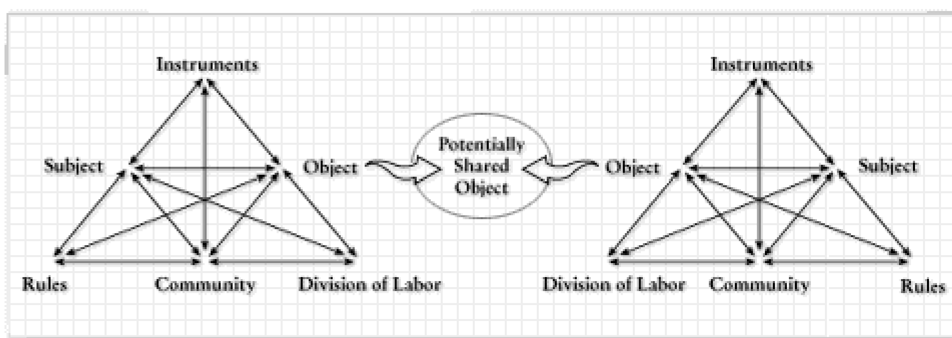

Figure 4. CHAT Shared Object Theory

CHAT, The Third Generation

Within an activity, participants bring to their environment the understanding of the various relationships they have formed over the years between individuals and society. The learned understanding influences the activity experience or may taint the outcome if not correctly intertwined (Blunt, 2006).The third generation CHAT framework offered a hypothesized conceptual framework for the present study. This framework allowed the researcher to explore the “dynamic relations between subjects, artifacts, and mediating social structures,” (Gros, 2007, p. 7) while operating within a networked activity system sharing *mathematics problems* as the object. Figure 5 presents a visual depiction of this hypothesized conceptual framework used to examine and document a networked activity system that transforms the object, *mathematics problems*, through a dual activity system comprised of (a) a mathematics lab activity and (b) a game play activity. The networked activity also shares an educational video game as the mutually exclusive tool between the two systems. Mathematics class motivation and academic achievement were the identified outcomes that were identified in the literature review and examined in this study. The variables represent the learning outcomes of the resulting unified activity system. Two instruments were used to measure the learning outcomes: (a) Keller's ARCS motivational survey and (b) countywide benchmark examination scores.

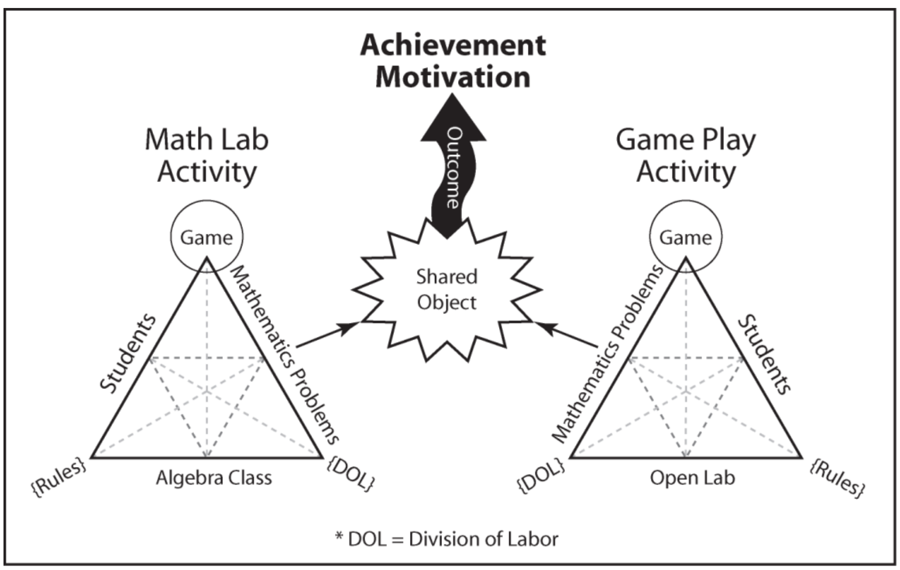

Figure 5. CHAT Shared Object Hypothesized Conceptual Framework

Using a hypothesized version of CHAT as the framework for this study, allowed the researcher to conduct a qualitative analysis to examine the connection, if any, between two systems sharing, not only an object, but a tool. The identified tool or treatment in this study was an educational video game. The qualitative examination provided support of the quantitative outcome results and permitted further exploration of the mediated relationship between the subject, s*tudents*, and the object, *mathematics problems* from the participants' point of view. CHAT places the "emphasis on how individuals transform objects in the environment and the activity systems that allow this transformation to become obvious" (Blunt, 2006, p. 42). A hypothesized conceptual framework explores shared components between activity systems while using a complete framework in order to examine previously reported female video game play barriers. The framework allowed the researcher to examine needs, preferences, and participatory feelings of the game play environment between the sexes.

If reviewing only the game play component of this dual activity, game play creates interactions between the player and the game, or the player and the interface used to complete the goal or objective of the game (Reese, 2007). Each participant approaches an activity, or game play, with a very unique perspective (Gee, 2003). Video games embody a game play atmosphere, and when used in an educational setting, educational video games become tools within a constructivist learning environment (Blunt, 2006). This environment creates an embedded social interaction that involves peers helping peers. Vygotsky's original theory of peers helping peers in a networked activity system is what may be missing to helping females overcome their lack of prior knowledge for video game play. Through a mutually inclusive mathematics lab activity involving educational video games, females can develop the concept of task and build upon a internal knowledge for socialization to benefit from the experience (Damis-Paraboschi et al., 2005). Educational video game systems help the game player overcome any missing prior knowledge components and mediate the relation between subject, object, and community in which they are playing. The environment also utilizes both people and tools to transform actions of the activity into learning (Barab et al., 2002).

Game play introduces a social aspect to learning whether played in either a multiplayer or single-player social gaming context. Players who do not understand the rules, division of labor, or tools, must interact, and rely upon community. Within a community setting, individuals are able to ask one another for support of the interface or simply to share in the excitement of accomplishment. In both the Mathematics Lab Activity and the Game Play Activity, a study of comparable systems exists with regard to educational video games used as tools or artifacts within a networked system. This permits the user to transform game play content into knowledge for the learning of algebra. Hsi (2007) spoke to the value of networking and collaboration as follows:

> Socio-cultural views of learning that draw upon activity theory, situated learning, and theories of distributed cognition are useful as promising approaches for examining the social networking, game play, identity formation, and collaborative practices in communities that are central to conceptualizing learning and activity of digital kids (Hsi, 2007, p. 1516).

This hypothesized conceptual framework allowed the researcher to join empirical research findings with regard to sex difference, academic mathematics achievement, and educational video gaming while using a third generation theory to investigate a dual activity system set in an open, social, lab setting for learning.

Using Educational Video Games as Tools Requires Motivation Measurement

Motivation, according to Clark (1999), is a goal directed activity that is "concerned with the amount of quality of the 'mental effort' people invest in achieving goals," (p. 1). For many decades, educational researchers have explored academic achievement and motivation with regard to in-class academic performance (Pinder, 2008). When learning to play a video game, the game player expends effort to learn the rules, controls, and the game's strategy in order to win. This activity alone requires an expenditure of mental effort.

However, if too much time and effort is needed to learn how to successfully play or win the game, a game player will experience overwhelming feelings of hopelessness and quit the experience altogether (Vogel et al., 2006b). This emotional state influences the task, in this case the video game play activity, and results in a lack of commitment (Clark, 1999). If motivation and additional effort are required by users to learn how to play an educational video game, it becomes important to "measure" the motivation or effort required.

Motivation has been an important variable when examining educational video games (Kebritchi, 2008). It needs to be examined in conjunction with achievement to ensure the treatment has not negatively affected overall motivation for the subject or the achievement of the students. Furthermore, decreased motivation may ultimately lead to a decrease in academic achievement score over time.

According to Kebritchi (2008), when examining studies concerning instructional games, two motivational theories have been prevalent: Keller's ARCS Model and Intrinsic Motivations Theory. Intrinsic Motivations Theory was determined to be inappropriate for use in the present study since it was described as providing for "prescriptive approaches and do not provide measurable variables” (Kebritchi, 2008, p. 50). Keller’s ARCS Model was selected as the preferred instrument to measure academic mathematics motivation, one of the two outcome variables indentified for use in the present study.

Components of Keller’s ARCS Model

Keller (2006) developed the ARCS model in conjunction with a motivational design process through a synthesis of available literature concerning motivation. Keller posited a four-step motivation process to support learning through categorical strategies, to not only stimulate, but to sustain motivation. Motivation, according to Keller, was the examination of “the amount of effort a person is willing to exert in pursuit of a goal” (Keller, 2006, p. 1).

Keller’s ARCS model focuses upon four general areas or factors of motivational theory: (a) Attention, (b) Relevance, (c) Confidence, and (d) Satisfaction. According to Keller, “These factors together with effort, the outcome of motivation, have a direct influence on the quantity and quality of a person’s performance” (Keller, 2006, p. 1). This study used an adaptation of the Keller’s ARCS model (Appendix C) for mathematics class motivation evaluation.

Although the ARCS model is a two-part model, the design component of this model was particularly germane to this study. The key components and individual strategies measured within this study using the Keller’s (2006) ARCS Model were as follows:

1. Attention (A). To establish attention, the instructor must (a) gain perceptual arousal, which can be gained through surprise events and uncertainty, or (b) present inquiry-based challenges such as real-life examples or conflict resolution scenarios.
2. Relevance (R). To establish relevance, the instructor should (a) present the learner with examples of worthiness that match the current learner needs, (b) build upon

current learner experiences, or (c) model desired outcome in an understandable fashion for the learner to match to their individual needs.

3. Confidence (C). To establish confidence, the instructor should help students (a) envision success, (b) by providing direct encouragement, or (c) by providing supportive feedback and rapport.
4. Satisfaction (S). Satisfaction for an experience is achieved through (a) direct rewards, (b) the establishment of beneficial situations, or (c) learner methods, which utilize the newly acquired skills in a real setting and in an effective manner.

Mixed-Method Approach

Clark (1999) wrote that motivational studies present several variables that need to be understood. He believed that one is truly only examining self-efficacy when exploring motivation and that motivation occurs when optimal working conditions between the understanding of tools and mastery are present. In a previous study concerning educational game effects, cooperative learning environments, achievement, and motivation, Ke & Grabowski (2007) found conflicting outcomes when examining video game play in a cooperative learning setting. Although results were positive with regard to educational video game usage, conflicting motivational outcomes warranted additional analysis. Ke & Grabowski revealed a correlation between an increase in achievement and ethnicity when working in cooperative groups. Pinder (2008), in using a mixed- method analysis that included ethnographic information, found that data regarding individual preference and performance was helpful in providing a clearer understanding of the activity system under examination.

Based on Clark's (1999) definition of motivation, the Keller’s ARCS model was used to examine and identify self-efficacy concerning mathematics classes only. It did not address motivation for the use of an educational video game as a learning tool. A mixed-method design, and the triangulation of data, was therefore, employed in instances where conflicting results surfaced with regard to motivation and achievement. The usage of a more robust theory, such as Cultural-Historical Activity Theory (CHAT), in addition to the examination of motivational outcomes, provided a more detailed analysis with regard to educational video game usage in the classroom between the sexes.

Dual-Activity Examination of Sex Difference

CHAT presents a concrete framework in which to examine two opposing activities (a) learning and (b) game play for the explanation of sex difference found within this conjoined system. The identified activities, (a) a mathematics-learning lab and (b) game play, formed a unified system, which represented a dichotomy of education versus entertainment in which one sex may triumph.

Girls have been identified as simply lacking interest in video games (Hayes, 2005) and lacking in the knowledge and understanding of video game play (Valenza, 1997). Ray (2004) believed that if game play is outside the realm of female experience, educators must examine sex difference and the views expressed or witnessed during game play in order to account for how females play games (Ray, 2004). Ultimately, prior knowledge, not for the subject, becomes the barrier to learning via video game play. Using an open social lab setting may allow females to overcome the lack of prior understanding of video gaming experiences or the rules of video game play previously identified as learning barriers.

As described in Gee's (2003) *What Video Games Have to Teach Us About Learning and Literacy*, different people develop different relationships with different game types. Through CHAT utilization, prior social or gaming environmental interactions and constructs (Gee, 2003) have been examined and have been of assistance in increasing female participation in future game play. CHAT also aided in exploring the activity of educational video game play as it related to the activity of the mathematics-learning lab. The qualitative nature of CHAT allowed the researcher to document the game setting females want and need. As reported by Entertainment Software Association's (2007) Essential Facts, females on average play less than males (62% males, 38% females), and those females who are playing have typically been over the age of 18 (p. 5). CHAT supports a natural investigation to verify findings of this nature. Additionally, CHAT allowed for the investigation of the topic of engendered game design, or game design specifically suited for one sex over another, from a personal perspective. Personal discussions were held to further explore the problems with "one size fits all" educational video games or games designed specifically to target a single sex (Kafai, 2006).

Through CHAT, the researcher was able to examine the actual context of the activity for potential improvement in the utilization of educational video games as in-class learning tools. Researchers have identified holistic components that are needed to implement a dual activity of this nature (Gee, 2003; Lim et al., 2006). A qualitative examination provided a less invasive research approach and was determined to be appropriate in assisting educators to discover which tools create successful learning atmospheres (Ke & Grabowski, 2007).

Though high comfort levels with technology exist among 21st century students (Provenzo, 2000) some teaching media or tool may be found to have a bias toward a particular sex. It has been stated that barriers of video game play as a media may possibly limit prior knowledge. This, in turn, could affect a student's ability to learn a subject once previously identified as having sex achievement gaps from the onset. By relying on the qualitative aspects of CHAT, the variables of motivation and achievement were able to be retained as the primary focus of the present study. However, findings from the activity were intended to provide a clear account of how to overcome differences if they were identified.

Summary

The review of empirical findings presented four unified themes regarding mathematics, sex differences, and video game play in the classroom: (a) inconclusive mathematics achievement findings between the sexes, (b) a debate regarding game play effects for learning, (c) notable sex difference findings regarding video game play habits and preference, and (d) the need for social inclusion during video game play to create a more holistic environment.

Historically, males and females have performed differently in areas of mathematics. However, findings did not support a significant difference, but, one of disparity between results. Whether studies examined performance, subject, or age of the sample, a consensus was not reached with regard to particular differences between the sexes when learning mathematics. Conversely, researchers did agree mathematics achievement score difference began to appear at 12 years of age.

Although achievement differences still existed, many turned their focus to examine newer forms of teaching tools in the area of mathematics: educational video games. Researchers explored educational video games as a method to bridge the gap between age and acceptance of technology. It is believed younger children have grown up with technology since birth and therefore newer technology is more suitable for learning (Prensky, 2001a). Throughout the many studies, empirical findings supported the use of video games in the classroom as a useful tool for learning. However, due to the zeal in which males accepted this technology, the debate regarding sex difference resurfaced.

A cause for alarm with regard to equity between the sexes appeared in the literature. Findings indicated females were at a disadvantage when using educational video games. In particular, there was a 1990s view that video games hindered female achievement due to a (a) lack of prior game play knowledge, (b) lack of socialization skills needed during game play, (c) use of hypersexualized game imaging, and (d) male-engineered approach that did not include female purpose within the design (De Castell & Jenson, 2003; Dickey, 2005; Valenza, 1997). Furthermore, researchers examining technology usage indicate video game play has the potential to isolate individuals since video game play is an individual activity (Gee, 2003).

Over time and acceptance of technology, opposing views with regard to sex differences and video game play and preference surfaced for debate. Findings indicated game play that included a social atmosphere, similar to female innate nature, the contextual setting helps females to overcome game play barriers and continue the momentum of support for game play as a learning tool. Research also indicated that changes in social aspects of video game play may be a viable solution for K-12 classrooms that are limited in time, money, and computer hardware when implementing educational video games in the classrooms (Kebritchi, Hirumi, Kappers, & Henry-Nease, 2008a; Kebritchi, Hirumi, Kappers, & Henry, 2008b; Rice, 2007). Studies demonstrated video game play that included social interaction created an all-inclusive environment (Winn, 2002). Additionally, Reese (2007) found social environments engage the learner and allow for proper activation of prior knowledge. Therefore, educational video game play has shown true potential for learning but the setting helped to mediate the tool for the user within an activity (Gee, 2003).

However, studies of this nature did not include a specific sex difference examination to summarize the implications of such configurations. Additionally, the review resulted in little evidence to support studies examining the design and implementation of video game play settings as opposed to focusing on the subject matter content. Therefore, the implementation of educational video game play in a social configuration while examining sex difference was warranted to find solutions for increasing learning outcomes (Bryce & Rutter, 2002; Ke & Grabowski, 2007). Additionally, the literature provided rationale for the use of CHAT in measuring the outcomes of academic mathematics achievement and mathematics class motivation. Data collected with regard to dual activity had the potential to maximize learning and add to the body of empirical findings in the field of instructional design.

CHAPTER THREE: METHODOLOGY

Chapter Three provides a comprehensive description of the methods used within this study to investigate educational video game effects, if any, when used as an in-class teaching tool. Chapter Three is comprised of the following sections (a) study design and sample description, (b) research questions, (c) hypothesis, (d) procedure, (e) video game description, (f) variables, (g) instrumentation, (h) instrument reliability and validity, (i) ethical considerations, (j) assumptions, (k) data analysis procedures, and (l) limitations.

Study Design and Sample Description

This study was conducted to investigate the utilization of an educational video game as a supplemental teaching tool to in-class activities and curriculum in a 7th-grade middle school classroom. To test the a priori hypothesis, this study utilized an experimental design that included a mixed-method analysis. Both the University of Central Florida (UCF), through its Institutional Review Board, and the Orange County Public School (OCPS) system approved this study (See Appendix D).

Population Exploration

The population for this study was comprised of a large urban middle school in Florida and was specifically focused on 7th-grade students. This middle school was situated in a city whose demographics for indicated the following ethnicity percentages: (a) White – 76.7%, (b) Black – 9.1%, (c) Asian – 3.2%, (d) Native American - 0.4%, and (e) Other - 10.6% (Public Schools Report, 2007). Of those surveyed, almost 18% of the people claimed Hispanic ethnicity (meaning 82% were non-Hispanic). Approximately half of the population was over the age of 25 and reported having graduated from high school or attended some college. The majority income bracket was between $66,000 and $99,999 annually.

According to the U.S. Census Bureau (2006), the city spent $5,070 per student in 2006 as compared to the national U.S. average of $6,058. There were approximately 18 students per teacher within this Middle School (U.S. Census Bureau, 2006). According to Public Schools Report (2007), at the time of this study, this middle school reported having 1,490 student enrolled, and boasted a 20.7% student to teacher ratio.

A purposeful sampling strategy obtained a sample of 60 consenting students and one consenting middle school teacher. The sample included an entire 7th-grade class of 60 students comprised of males (n=29) and females (n=31). The original larger study was comprised of a group of 327 students that was narrowed to 60 so as to have a sample that mirrored the age group that has been noted as being unaffected by mathematics achievement score changes (Hyde et al., 1990b; Leahey & Guo, 2001).

The study took place over an 18-week term, which began in August 2007 and concluded in December 2007. An educational video game was applied as the treatment during that period. The applied treatment included a suite of single and multi-player educational mathematics video games that addressed pre-algebra and algebra concepts designed in mission format. There were 20 missions in total, all of which were aligned to both state and national mathematics standards. Appendix A provides an example of the curriculum alignment for Mission 2. The video game suite provided visual as well as verbal feedback during play that was planned to engage students in learning of mathematics algebra concepts. The treatment was advertised by the vendor as providing an immersive 3-D video game and gaming world for learning.

Two types of measurement instruments were used: (a) district (countywide) benchmark exams, measuring academic mathematics achievement, and (b) Keller's ARCS motivation survey, measuring mathematics class motivation were used in the study. Data on academic mathematics learning outcomes and motivation were collected. Additionally, the mixed-method analysis involved observational and interview data to support the quantitative findings during the 18-week term. These additional instruments uncovered preference and performance data between the sexes previously unreported through other data collection methods.

Data included (a) academic mathematics achievement scores, (b) mathematics class motivation, (c) student game design suggestions, (d) computer and game play usage between the sexes, (e) perceived game play statements with regard to differences between the sexes collected through student cohort and teacher interviews, and (f) observed classroom environment data recorded during in-class teaching and educational video game play activities. The researcher gathered student/teacher interview data along with in-class observational data once per 9-week term using the Horizon, Inc. protocol. The mixed-method analysis allowed for the triangulation of research findings reported for academic mathematics achievement and mathematics class motivation outcomes.

Research Questions and Hypothesis

Within this study, the researcher defined the term *Sex Difference* to refer to biological difference, whereas, the term *Gender Difference* referred to societal interaction difference based upon sex of the individual. Therefore, this study made use of these terms as needed, but attempted to utilize the statement "between the sexes" where possible.

This study was conducted to answer five research questions. Six hypotheses were used in responding to the questions. Following are the research questions and the supporting hypotheses.

1. Are there differences in academic mathematics achievement scores between sexes when using an educational video game as an in-class tool or media?

   H_0Female mathematics achievement scores will not differ from male mathematics achievement scores statistically.

2. Are there differences in motivation scores between sexes when using an educational video game as an in-class tool or media?

   H_0Female motivation scores will not differ from male motivation scores statistically.

3. Does academic mathematics achievement score change when using an educational video game to learn algebra?

   H_0Pretest mathematics achievement scores will not differ from posttest mathematics achievement scores, statistically.

   H_0There is no interaction between mathematics achievement score change and gender.

4. Does motivation toward mathematics class change when using an educational video game to learn algebra?

   H_0Pretest mathematics achievement scores will not differ from posttest mathematics achievement scores, statistically.

   H_0There is no interaction between mathematics achievement score change and gender.

5. What are the observed differences in video game play environments by sex? (Qualitative Question)

Procedures

Situated within a larger countywide study, the present study was conducted to investigate only 7th-grade students and the educational video game effects, if any, upon mathematics class motivation and academic mathematics achievement between the sexes using an educational video game as a treatment. This dissertation focused on sex difference outcomes when the subjects were taught algebra using an educational video game. The design analyzed two outcomes (a) academic mathematics achievement scores in the form of district (countywide) benchmark exams and (b) mathematics class motivation in the form of Keller's ARCS model.

A purposeful sampling strategy was used to identify participants for inclusion within the study. The supervising professor of the larger project completed the random assignment from which the sample resulted.

Table 3 presents the experimental research design for the male and female groups examined. The treatment group contained those students taught pre-algebra lessons enhanced by the implementation of an educational mathematics video game suite signified by (X) in Table 3. The video game suite contained missions to teach pre-algebra and algebra using a 3D educational mathematics video game with specific correlation to National Council of Teachers of Mathematics (NCTM) and Florida Sunshine mathematics standards.

Table 3.
Experimental Research Design

Sample	18 Week Term
Males	O_{dem} O_{prea} O_{prem} X1 O_{posta} O_{postm}
Females	O_{dem} O_{prea} O_{prem} X1 O_{posta} O_{postm}

Legend:
Oprea =Pretest Benchmark Achievement Measure
Oprem =Pretest Motivation Survey
Oposta =Posttest Benchmark Achievement Measure
Opostm =Posttest Motivation Survey
Odem =Pretest Demographics Survey
X =Treatment

As shown in Table 3, the instruments used to gather data were: (a) academic mathematics achievement data survey, as measured by district (countywide) benchmark exams, and (b) a mathematics course motivation survey. Quantitative data collection was initiated at the beginning of the 2007 school term and completed at the end of the 18-week term in December 2007. Qualitative data collection took place once per nine-week session totaling two collection periods to establish a pre and post data collection. The class teacher collected informed consent forms from students and delivered them to the researcher on a weekly basis to ensure privacy for subjects. The class teacher administered the motivation and achievement data surveys and delivered the scantron output directly to the researcher for tabulation of the data. In the Spring of 2008, a repeated-measure statistical analysis found within SPSS, version 14, supported the examination of quantitative outcome data.

To gain qualitative data, the researcher conducted in-class classroom observations and face-to-face (F2F) student cohort and teacher interviews twice during the term the Horizon, Inc.

protocol method. The researcher elicited opinions, perceptions, and information about the general use of video games and video game play. Questions sampled both personal and educational beliefs with regard to video games and video game play.

Each interview took place during an approximate 25-minute session, during which a 30-item survey was administered. Questions posed were both open- and closed-ended. Interviews were conducted in cohort fashion and informal. The observation and interview protocols are contained in Appendix E and F, respectively. Data security and maintenance were a high priority throughout the study to protect teacher and student privacy. Therefore, data were kept in a locked on-campus location. The researcher obtained parent and teacher consent at the onset of the study. Consent forms are contained in Appendix G (parents) and Appendix H (teacher). To ensure post-interview data availability and future interpretation, the researcher taped each interview and gained verbal consent.

Quantitative Data Analysis Procedures

The researcher used a repeated-measure statistical analysis found within SPSS software, version 14, to analyze the data after the end of the 18-week term. In identifying learning outcomes of the game, the researcher collected both (a) academic mathematics achievement in benchmark exam form, and (b) mathematics class motivation measures in motivational survey form. Chapters Four and Five analyze and discuss sex difference findings, if any, when using an educational video game as an in-class teaching tool. Additionally, Chapters Four and Five include (a) a sample description, (b) descriptive data information (c) statistical means, (d) degrees of freedom, (e) F statistics, (f) standard deviation, and (g) an evaluation of interaction effects and changes in scores from pre to post data collection.

Qualitative Data Analysis Procedures

According to Glesne (2006), dealing with *fat* data requires methodical organization. Maintaining data organization during the collection process reduces data bulk, otherwise found to be intimidating, and eases data manage tasks. To ensure thorough data analysis within a qualitative study, Glesne (2006) suggested "writing memos, making analytic files, and developing preliminary coding schemes during the initial capture" (p. 151). Glesne also believed that by using visual aids, such as matrices, or graphs, a researcher is more able to expose the data gaps. By identifying data gaps, additional questions, avenues of analysis, and themes emerge.

During the collection of interview data, the researcher presented an open and unbiased lens to the study's outcomes. The researcher maintained a singular interest in learning how to best understand and employ qualitative methods for following proper qualitative procedures in order to ensure outcomes that would either support or refute the hypotheses. The researcher attempted to remain impartial, while maintaining her research curiosity, in interacting with all study participants.

Data analysis took place using Glesne's (2006) theme-based data coding approach to allow for themes and overarching topics to emerge naturally. Overarching topics and themes create a personal story for the data based upon coding with the sole purpose of supporting quantitative findings. The analysis began with transcription and reflection of what each interviewee said along with the creation of a spreadsheet to post all data per interviewee in columnar form to triangulate collected data whenever possible. In an effort to understand patterns, similarities, and consistencies of interview data, the researcher used both a teacher and student matrix. The details related to the matrix data are discussed in Chapter Four. The matrix provided a method for quick and high-level observation of patterns that emerged.

Video Game Description

The treatment was an immersive 3-D educational video game suite. The suite contained two versions of the video game: (a) single-player and (b) multi-player. Because the contextual setting in which students play either version of the video game was the same, game versioning was outside the scope of this study and differences in versions have not been discussed in this description. In this study, the teacher elected for his students to play the single-player version of the game.

The educational video game and stated treatment used by the 7th-grade teacher only enhanced teaching methods but did not replace them. In addition, the participating middle school was an alpha game adopter and participated with the vendor in the previous year to evaluate the video game suite. During this early adopter phase, the vendor acknowledged the participating teacher as an expert game player and curriculum alignment specialist for the game suite. However, the students in this study did not participate in the early adopter phase and are unaffected by the previous partnership.

For clarification, the treatment in this study was an educational video game and this study's purpose was to examine video game effects between the sexes. For reference, Eclesz et al. (2005) classified video games by the following categories:

> (a) action games requiring dexterity and fast reaction, (b) adventure games requiring the player to control one or more characters through a complex and well-developed storyline, (c) strategy games simulating real or imaginary war situations, or the life of a nation or

community, (d) simulation games modeling real (cars or airplanes) or fictional (spaceship) vehicles, and (e) sports games realizing individual or team events (p. 118).

The treatment was classified by Eclesz et al. (2005) as an action game, but was a commercial video game by general standards. This game had a unique quality. Although it was a commercial video game, it was created with an educational focus in mind and its design was aligned to mathematics standards as seen in Appendix A. The treatment was applied specifically for educational purposes and unethical content was not a concern due to the environment in which it was used.

Game Play Environment

Though originally built in 1908, the middle school within this study appeared to be relatively new as it underwent renovations to become a Florida State Demonstration School in 2001. The renovations included updates to the previous technology infrastructure within each building. Network and computing readiness, both hard-wired and wireless, were present throughout the three building campus. Each grade level contained teams that populated three to four classrooms of a quad. Teams and classrooms were located adjacent to a common work/community area that each team shared. Common areas had lockers, desk clusters, and computer stations that contained five to six personal computers. This type of setting provided each teacher with an additional technology instruction and student video game play area in an open lab setting and allowed the general population to intermingle at will. This common area was the game play setting where teachers released their students from the learning classrooms to an educational video game setting and the setting observed during the 18-week project.

Instrumentation

The following instruments aided data collection: (a) mathematics academic achievement exams, collected pre to post over the eighteen-week term, (b) mathematics class motivation, collected pre to post over the eighteen-week term, (c) observations, collected twice per 18-week term, based upon the Horizon, Inc. protocol, and (d) face-to-face (F2F) interviews, collected twice per 18-week term, based upon the Horizon, Inc. protocol.

Observations and interviews were used to enhance the quantitative analysis. These data provided support for the quantitative analysis concerning (a) student and teacher game play, (b) personal game play and interface preferences, including likes and dislikes as stated by the user, (c) previous game play experience, (d) observed game play differences between the sexes, (e) reported differences between the sexes as stated by the user, and (f) home computer ownership and utilization. Appendix E and F provide a copy of the Horizon, Inc. protocol for additional review. Appendix I and J contain student and teacher interview documentation. Lastly, the Game Player Background survey, found in Appendix K, was used to collect demographic information.

Instrument Reliability and Validity

"Reliability can be represented in several ways, but the concept essentially means that the test provides consistent measurement" (Florida Department of Education, 2007, p. 37). Two instruments, (a) district (countywide) benchmark exams, and (b) Keller's ARCS motivational survey, were used to collect quantitative outcome data regarding (a) student academic mathematics achievement, and (b) mathematics class motivation respectively. Each instrument's creator reported reliability and validity measures using "Cronbach's alpha testing based upon classical testing theory" (Florida Department of Education, 2007, p. 38). Additional data provided below summarizes both reliability and validity for each of the instruments.

District Benchmark Exams

Students' academic mathematics achievement scores collected rely upon a standard countywide benchmark exam, which attempts to predict the scores of the Florida Comprehensive Assessment Tests (FCAT). Internal consistency is the most commonly used rating when communicating reliability measures for such examines and is reported using Cronbach coefficient ratings. Whereas, validity results refer "to the extent to which the test measures the characteristic it is supposed to measure" (Florida Department of Education, 2007, p. 47).

The school district therefore hired The Princeton Review to create and provide reliability and validity measures for the district (countywide) benchmark exams in reading and mathematics. The district (county-wide) benchmark exam data for both reading and mathematics was published in the 2008 report entitled *Interim psychometric report for the Orange County Public Schools. Test 1 & 2.* The Princeton Review (2008) reliability estimates for district (county-wide) benchmark mathematics tests 1 & 2 for the 2007-08 school year for 7^{th} graders ranged from .78 to .83. Overall "test reliabilities were moderate to good and ranged from .73 to .84 for Test 1, from .82 to .86 for Test 2A" (p. 4).

Motivational Surveys

A version of Keller's ARCS Model (Keller, 1987a; Keller, 1987b) instrument aided in the collection of motivation measures regarding the mathematics course. The designer of the instrument established a Cronbach coefficient rating level for each area of motivation examined: (a) Attention .89 (b) Confidence .90, (c) Relevance .91, and (d) Satisfaction .92. The overall instrument presented a .96 Cronbach coefficient rating level. The instrument and reliability rating are located in Appendix C.

Observations and Interviews

In additional to the previously identified surveys, the study's design included two sets of observational and interview data collection periods over the 18-week term. These additional sources of data were used to gather preference and performance data between the sexes previously unreported through the other data collection instruments. Observations were scheduled on a once per 9-week term basis and occurred at an agreed time between teacher and researcher. Each observed session included the use of the educational video game as it related to the study.

To complete each 9-week interview, the consenting teacher, based upon roster numbering, employed a simple random sampling technique to select student participants for interview. Although a "random sample does not guarantee that all population characteristics will be represented," (Drew, Hardman, & Hosp, 2008, p. 89) it has been affective in limiting the potential for bias or reducing the possibility of underrepresentation (Drew et al., 2008).

Interviews between students and the researcher were conducted without the teacher being present. Each interview lasted 25 to 35 minutes and took place during an in-class session. During interview sessions, the teacher did not use the treatment to ensure interview students did not miss a treatment session. Each 9-week term contained one interview session for both teacher and student. Thus, the 18-week data collection period permitted two interviews per grouping. The identified student interviewees were interviewed in cohorts of 2-8 students in mixed-sex groups.

Ethical Considerations

Teachers and parents provided informed consent at the beginning of the study. Consent form collection began at the beginning of the school term and continued throughout the term on an as needed basis for study participation. The teacher collected consent forms directly from each student on a daily basis. The teacher submitted returned consent forms directly to the researcher on a weekly basis for data recording, security, and storage purposes.

There were no unanticipated risks noted during this study. Participants were not given compensation for participation and were able to withdrawn from the study at any time without reason or penalty. Initially, the researcher recorded student identification. However, to maintain student privacy, the researcher removed student identification during SPSS compilation for analysis and reporting. Coding also ensured all identifiable data contained no student content. The researcher secured the data at a locked university location to retain privacy and integrity of record keeping throughout the 18-week process. Since the research was conducted in a K-12 school setting where children were present, ethical issues were of particular concern. The researcher maintained vigilant protection of student data with a password protected spreadsheet throughout data collection.

Assumptions

Assumptions of this study were as follows:

1. Respondents answered all exam questions and survey items in an honest and timely fashion.
2. All instrumentation accurately measured participants' academic mathematics achievement scores and affective measure as it relate to educational video game play.

3. Students did not take part in game play, nor were they exposed to, the video game either in class or at home prior to the treatment period.
4. Students may have used the at home version of the treatment available through download from vendor's website once the study commenced.

Limitations

This study presented varying limitations with regard to teacher and student in-class time constraints when completing student cohort and teacher interviews. It is possible that there were unforeseen time constraints on teacher workdays that were unreported to the researcher. Because, these constraints did not appear to affect the overall research project and did not, therefore, present additional limitations.

Prior video game play of other external video games by students may have affected the overall generalizability of the study. However, data regarding previous game play was recorded, identified, and discussed within the Results section of the dissertation to attempt to account for any unintentional effects.

Lastly, the focus of this study was limited to a single middle school, in a single county, and completed over a single period. Factors affecting the term, school system, or the mathematics curriculum on a national level may have influenced the data during the collection period, but were unknown, and remain so, to the researcher. It was anticipated that the use of a mixed-method data collection and analysis process and triangulation of the data would provide the necessary mechanisms to overcome any inherent limitation created within the school or school system during the collection period.

CHAPTER FOUR: RESULTS

There has been some empirical evidence that video games are (a) effective tools for enhancing learning (Garris et al., 2002), (b) helpful in "understanding complex subject matter" (Ricci, Salas, & Cannon-Bowers as cited in, Ke, 2008, p. 1609).   Some researchers have expressed their beliefs that video games are engaging and sustain attention (Gee, 2003; Squire, 2004). There have not been findings, however, that students gain a deeper understanding of any subject matter content when using educational video games.

Presented in this chapter are the results of the 18-week study during which the researcher investigated student beliefs, their knowledge construction, if identifiable, and general usage of technology in a classroom when utilizing an educational video game as a teaching tool and research treatment. The chapter contains a summary of the analysis of the data based upon quantitative and qualitative mechanisms used to examine the research questions. Included in the chapter is a detailed description this study's sample and the results related to (a) academic mathematics achievement and (b) mathematics class motivation variable analysis.

To understand whether educational video games were viewed as effective tools for learning, it was important not only to measure outcomes. It was important to understand both student and teacher beliefs toward such technology to gather a usage perspective from the vantage of the end user. It is for this reason that observational and ethnographic accounts with regard to in-class educational video game play, preference, and setting from both teachers and students alike have been included in this chapter. When appropriate, the analysis was conducted using a repeated-measure statistical examination, using version 14 of SPSS, to analyze outcome data.

Population Exploration

The research study took place at a middle school in central Florida. This middle school was situated in a city whose demographics for indicated the following ethnicity percentages: (a) White – 76.7%, (b) Black – 9.1%, (c) Asian – 3.2%, (d) Native American - 0.4%, and (e) Other - 10.6% (Public Schools Report, 2007). Of those surveyed, almost 18% of the people claimed Hispanic ethnicity (meaning 82% were non-Hispanic). Approximately half of the population was over the age of 25 and reported having graduated from high school or attended some college. The majority income bracket was between $66,000 and $99,999 annually.

According to the U.S. Census Bureau (2006), the city spent $5,070 per student in 2006 as compared to the national U.S. average of $6,058. There were approximately 18 students per teacher within this Middle School (U.S. Census Bureau, 2006). According to Public Schools Report (2007), at the time of this study, this middle school reported having 1,490 student enrolled, and boasted a 20.7% student to teacher ratio. Table 4 presents a visual representation of this middle school's student population by race as reported by Public Schools Report (2007).

Table 4.
Middle School Population by Race

Race	Males	Females	Total
American Asian/Alaskan	5	1	6
Asian/Pacific Islander	20	17	37
Hispanic	152	145	297
Black (Non-Hispanic)	112	146	258
White (Non-Hispanic)	461	431	892

The middle school examined in this study was not lacking in technology resources due to recent school renovations, which allowed the builders to equip classrooms with newer technology dated after the millennia for use in teaching and learning.

Sample Exploration

Table 5 provides an overview of the sample with regard to gender, ethnicity, game play, and computer frequency.

Table 5.
Sample Demographics (n=60)

Demographic	Category	Percent
Gender	Male	48.3
	Female	51.7
Ethnicity	White	45.0
	African American	28.3
	Hispanic	21.7
	Other	3.3
Home PC	Yes	68.3
	No	13.3
Computer Skill	Power User	20.0
	Proficient	33.3
	Novice	18.3
	Beginner	8.3
	Nonuser	5.0
Game Play	Every Day	16.7
	3-5 Times a Week	6.7
	1-2 Times a Week	13.3
	Not Often	31.7
	Not at All	15.0
Computer Frequency	Every Day	5.0
	4-6 Times a Week	11.7
	1-3 Times a Week	15.0
	Not Often	36.7
	Not At All	15.0

During observations, the recorded class section sizes ranged from 21-25 students per section and were comprised of 51-75% white, non-Hispanic, students. The sample under examination yielded 60 (n=60) consenting students (males=29, females=31). Of the 60 students, 17 students were assigned to the Mathematics 2 Advanced section. The remaining 43 students were enrolled in Mathematics 2. Not all students attended class on the day of each survey. Therefore, the sample size varied slightly per variable in the analysis of academic mathematics achievement and mathematics class motivation. The sample was, however, viable for the purpose of the study.

This sample was unique in the fact that they are learning algebra while enrolled in 7th grade and not taking Algebra I or PreAlgebra offerings. The subject of algebra is somewhat unusual to be addressed in normal 7th grade Mathematics 2 or Mathematics 2 Advanced mathematics classrooms. For reference and review, Appendices L and M contain the Florida Department of Education benchmarks for Mathematics 2 and Mathematics 2 Advanced courses examined in this study. It was, therefore, only natural to examine academic achievement scores as part of the present research. Additionally, this middle school was using immersion techniques that focused on academic topics rather than student learning level or mental capacity. In doing so, students of all learning capacities have been intermingled in every unified classroom. This study does not report the number of those Exceptional Students (ES) who were members of this sample's roster as this was brought to the attention of the researcher four weeks into the school term. Data collection instruments did not include items to gather this type of information.

The male teacher leading the sample of students was a self-identified "GenX" person, who had over 10 years of classroom teaching experience. He was a self-proclaimed inquiry-based teacher. He identified himself as 3.5 on a 1-5 Likert rating scale where 5 represented inquiry-based teaching and 1 was teacher-directed. According to him, being an inquiry-based teacher meant using “manipulative based [teaching], where they [students] do an activity and after that activity, they [students] figure out how it applies to what they [students] are doing” (Teacher A, personal communications, October 25, 2007).

In face-to-face (F2F) interview sessions, the mathematics teacher identified himself as having “awesome” computer proficiency skills (Teacher A, personal communications, October 25, 2007). During the initial interview process, the mathematics teacher joked when asked “Which game did you play, personally, and approximately how much of the game did you play?” by stating, “Everything . . . I’m a mathematics master. Kathy’s number 1, I don’t know who she is, but I’m number two in the country” (Teacher A, personal communications, October 25, 2007).

Table 6 provides an overall demographic representation of the teacher’s profile. This teacher was an early adopter of the treatment used in the present study. In previous years, the teacher had helped the video game vendor analyze and align the game’s content to national and local mathematics standards on a per game mission basis. Although the teacher was versed in all versions of the treatment’s gaming suite, he elected to utilize only the single-player version of the video game throughout the 18-week term. Overall, the teacher shared positive perceptions for all educational video games and innovative educational tools (Teacher A, personal communications, December 13, 2007).

Table 6.
Teacher Demographic & Game Play Data

	Gender	Ethnicity	Birth Class	Degree	Cert & Level	Years Teach	Subject	Approach (1 Teacher – 5 Student)	Computer Skill	Game Player (1-10) (low to high)
Teacher	M	W	Gen X	BA in Math Ed	Prof/ 5-9	10+	7th & 7th Adv.	3.5 (student-directed)	Awesome	7

Quantitative Findings

Repeated-measure Introduction

"One advantage of (using) a repeated-measure design is that it requires fewer subjects than the between-subjects design does and may prove more practical than a between-subjects design" (Myers & Well, 2003, p. 343). When using a repeated-measure, the use of fewer subjects provides greater efficiency as it lowers the error of variance due to allowing for fewer subjects (Myers & Well, 2003).

Hypotheses 1 - 3

H_0Pretest mathematics achievement scores will not differ from posttest mathematics achievement scores statistically.

H_0Female mathematics achievement scores will not differ from male mathematics achievement scores statistically.

H_0There is no interaction between mathematics achievement score change and gender.

A one-way within-subject analysis of variance was conducted (n=56) to evaluate the effects of educational video game usage as a teaching tool on academic mathematics achievement between the sexes. Table 7 presents means and standard deviations for academic mathematics achievement scores. The independent variable was gender (n_{males}= 25, $n_{females}$= 31).

The academic mathematics achievement main effect and the academic mathematics achievement X gender interaction effect were tested using the criterion of Pillai's Trace.

Table 7.
Mean Score Analysis By Gender for Academic Mathematics Achievement

Measurements	Males		Females	
	M	SD	M	SD
Achievement Pre	45.28	16.15	44.13	14.25
Achievement Post	53.76	15.96	52.26	17.28

The result of the repeated-measure analysis for academic mathematics achievement main effects was significant (Pillai=.29, F=21.8, df=1, 54, $p<.05$). Thus, there was a statistically significant *increase* in academic mathematics achievement for both males and females as indicated in Figure 6. However, academic mathematics achievement X gender interaction effect was not significant (Pillai<.01, F=.01, df=1, 54, $p>.05$). Of the variance in score, 29% was accounted for by the change in academic mathematics achievement scores (F=21.8, df=1, 54, $\eta^2=.29$).

There was no statistically significant difference in academic mathematics achievement between males and females (F=.12; df =1, 54; $p>.05$), as presented in Table 8. Additionally, gender accounted for less than 1% of variance in score change in academic mathematics achievement ($\eta^2<.01$).

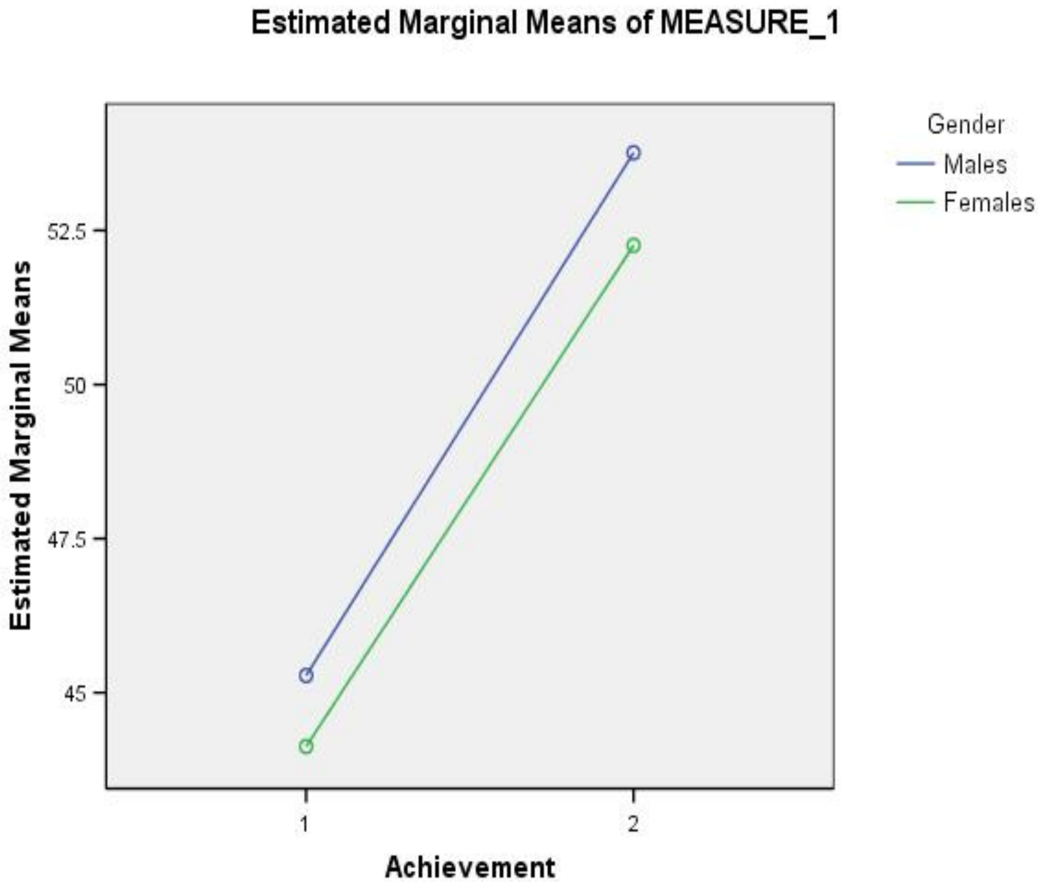

Figure 6. Academic Mathematics Achievement Scores by Gender

Although there was no statistically significant difference between males and females, males scored higher during initial testing when compared to females. Similarly, the posttest results demonstrated in Table 7, also favored higher post male mean scores as compared to female post mean scores. In contrast, however, Figure 6 presents a graphic representation indicating a unified *increase* of academic mathematics achievement scores by both sexes.

Table 8.
Results of Academic Mathematics Achievement and Gender

Measurements	F	DF	Eta
Within			
Achievement	21.78*	1, 54	.29
Achievement * Gender	.01	1, 54	<.00
Between			
Gender (Achievement)	.12	1, 54	<.01 (p>.05)

* (p < .01)
** (p < .05)

Hypotheses 4 - 6

H_0Pretest motivation scores will not differ from posttest motivation scores statistically.

H_0Female motivation scores will not differ from male motivation scores statistically.

H_0There is no interaction between motivation score change and gender.

A one-way within-subject analysis of variance was conducted (n=49) to evaluate the effects of educational video game usage as a teaching tool upon mathematics class motivation between the sexes. Table 9 presents the means and standard deviations for mathematics class motivation. The independent variable was gender (n_{males}= 25, $n_{females}$= 24). The mathematics class motivation main effect and the mathematics class motivation X gender interaction effect were tested using the criterion of Pillai's Trace.

Table 9.
Mean Score Analysis By Gender for Mathematics Class Motivation

Measurements	Males		Females	
	M	SD	M	SD
Motivation Pre	74.80	8.76	72.30	14.42
Motivation Post	72.64	11.70	71.38	13.96

The result of the repeated-measure analysis for mathematics class motivation main effects was not significant (Pillai=.02, F=.79, df=1, 47, p>.05). Thus, there was no statistically significant increase in mathematics class motivation for both males and females. Additionally, mathematics class motivation X gender interaction effect was not significant (Pillai<.01, F=.12, df=1, 47, p>.05). Only 2% of variance in score was accounted for by mathematics class motivation (η^2=.02).

Although there was no statistically significant difference between males and females for mathematics class motivation, males scored higher during initial testing when compared to females. This is displayed in Table 9. Similarly, the posttest results presented in Table 9 also favored higher post male mean scores as compared to female post mean scores. Additionally, variability increased between the sexes indicated by a 2.94 change in male standard deviation ($SD_{motivationpre}$=8.76, $SD_{motivation\ post}$=11.70) scores as compared to a -.46 standard deviation score change for females ($SD_{motivationpre}$=14.42, $SD_{motivation\ post}$=13.96). However, no significant difference in mathematics class motivation was found between the sexes (F=.37; df =1, 47; p>.05). As presented in Table 10, gender accounted for less than 1% of variance in score change in mathematics class motivation (η^2<.01).

Table 10.
Results of Mathematics Class Motivation and Gender

Measurements	F	DF	Eta
Within			
Motivation	.79*	1, 47	.02
Motivation * Gender	.12	1, 47	<.00
Between			
Gender (Motivation)	.37	1, 47	<.01 (p>.05)

* (p < .01)

In summary, as seen in Figure 6, males reported higher initial mean academic mathematics achievement scores. Additionally, as seen in Table 9, motivation scores mirror academic mathematic achievement, in so much, that the initial mathematics class motivation scores also are higher for males than females. Although academic mathematics achievement scores indicated a positive result or an increase in achievement and posted significance, mathematics class motivation scores do not present such findings as there was no difference in score pre to post, or between the sexes. Ironically, both sexes experienced similar results within both variable analyses. Males, however, appeared to always begin initially higher than females and continued with a steady increase in academic achievement score as learning continued with the assistance of in-class instruction and this particular educational video game during the 18-week term. Nonetheless, there were no statistically significant findings between the sexes for either variable.

Qualitative Findings

According to Glesne (2006), dealing with overwhelming quantities of data that qualitative research produces requires a detailed, even a methodical approach. Organization becomes the key for allowing themes and categories to emerge during analysis. “Keeping up with data organization during the collection process makes the bulk less intimidating and easier to manage” (Glesne, 2006, p. 151). Therefore, to manage qualitative data the researcher must keep memos, stay organized, and “develop[e] preliminary coding schemes” (Glesne, 2006, p. 151) for use during analysis. According to Glesne, detailed transcripts and matrices can help maintain a visual representation in what can be complicated in the process of theme analysis (Glesne, 2006). To begin the qualitative portion of this analysis, data were transcribed using electronic mechanisms in an effort to understand patterns, similarities, and consistencies.

This portion of the analysis addressed the fifth research question, which was “What are the observed differences in video game play environments by sex?” This section has been organized to address the following dimensions: (a) Classroom Setting and Game Play Environment, (b) Teaching Method as an Asset, (c) Implementation Concerns, (d) Design Suggestions, and (e) Game Play and Preference Observations. Additionally, this section includes summaries of the detailed verbal account from both teacher and students compiled during the study, which provide support of the overarching themes and categories that emerged during data analysis. Two matrices are also presented to provide an overview of patterns and categories identified during the analysis.

Classroom Setting and Game Play Environment

The middle school setting was unique as it was divided between two buildings. Each building served both seventh and eighth graders. This middle school divided seventh graders into learning teams. Each team had their own quad containing teacher offices, lockers, learning classrooms, and computing stations. The classroom did not contain personal computers, but each student had calculators readily available for use. The teacher walked around the classroom using a tablet pc to check-in homework and take attendance. This teacher, however, conducted lectures using an overhead and a voice-increasing microphone, which hung around his neck and worked in conjunction with the smart components of the classroom. The classroom was rich in resources from textbooks to wall hangings, but was semi-crowded as each section of this teacher's roster contained between 21 and 30 students. In-class student work areas contained paired-desks contained in eight rows facing forward.

The game play setting, however, offered a completely different perspective than that of the classroom setting. Students did not play the educational video games or use computers in their learning classroom, but did so outside of the classroom in the open computing quad. Figure 7 provides a graphical blueprint of the open video game quad which was the area used to play the educational video game or treatment within this study. The quad is a shared technology area made available for all teachers on the team. It required coordinated use since there were not enough computers for all students from all learning classrooms to use at the same time.

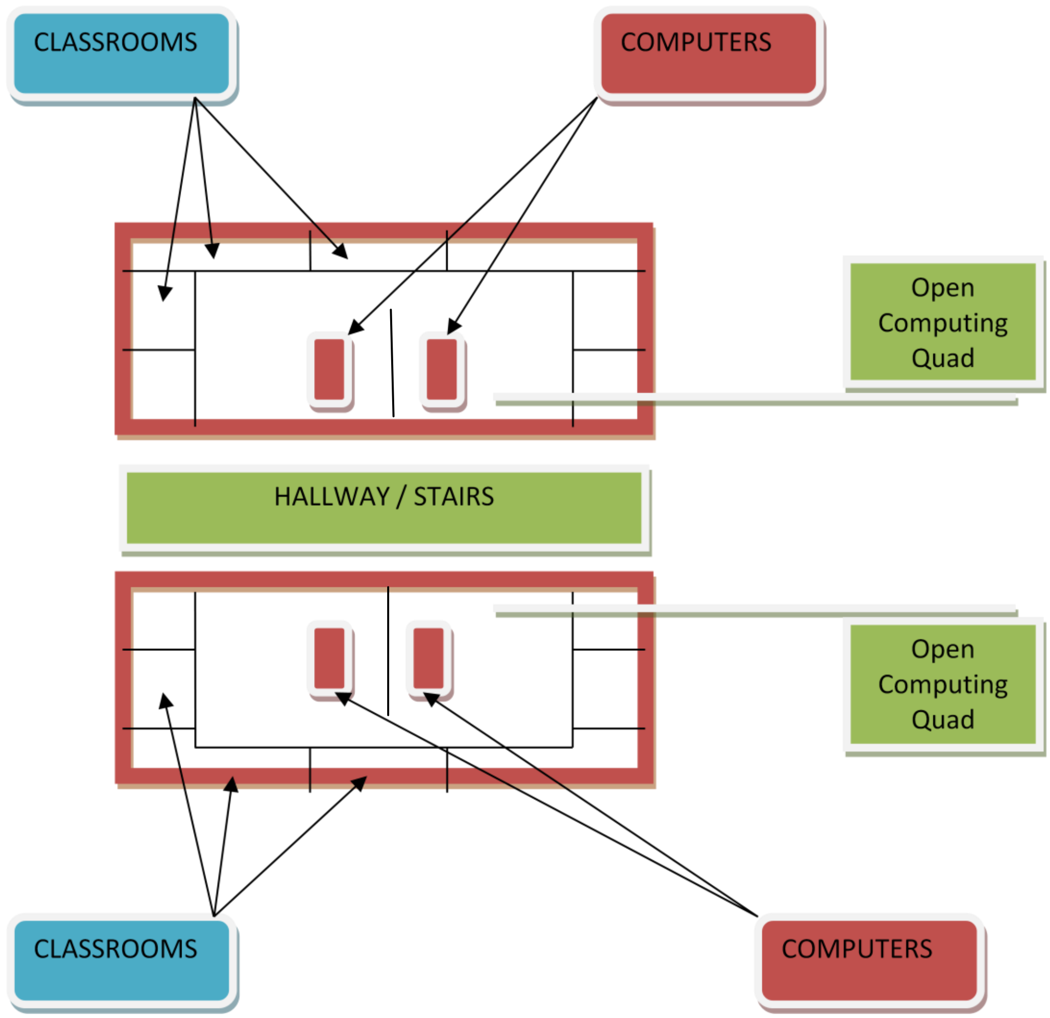

Figure 7. Open Video Game Play Quad

During an initial in-class observation, the mathematics teacher was extremely mindful and began class by reminding students about the next day's quiz. He worked at a comfortable pace to allow students to record answers slowly. The classroom climate was respectful as students immediately reacted when spoken to and never interrupted. When a student made a mistake, the teacher, in turn, returned the respect by saying, "No big deal, better to learn today and figure out our mistakes, than tomorrow during the test" (Teacher A, personal communications, October 25, 2007). The teacher took time to engage in one-on-one discussions to help students understand the board opener or homework assignment. When a student asked a question that may be beneficial to the entire classroom, he involved all students in a unified discussion to provide the explanation to the entire class.

During game play observation, it was semi-difficult to keep an eye on in-class activities and game-play activities conducted in the computing quad. Therefore, research observations remained solely focused on the game-play activities in the computer quad. However, the teacher was successfully able to move between rooms. He attempted to maintain rapport with his students and bring students who were not studying back into the activity rather than disciplining them. This teacher's in-class demeanor and self-reported game play habits appeared to be an asset and helped him to maintain gaming activities in the mixed-room setting with ease.

Teaching Method as an Asset

With this study focusing upon technology utilization, it was surprising that in the survey students readily commented upon the teaching method used by the teacher rather than simply on the video game. One student gave the ultimate compliment to the teacher by stating "I never understood fractions until now . . . he, um, explains the whole thing in two different ways . . . he makes sure you get it . . . [and he] asks questions" (Student Cohort B, personal communications, December 13, 2007). During observation, this teacher allowed students to raise their hands and help other students finish the assignment. Talking about mathematics concepts was not discouraged but encouraged. This type of collaboration was also encouraged during game-play. The teacher allowed student-to-student discussion for both the exchange of game functionality information and mathematics problem solving information. One could hear the students moving ahead by saying “yeah,” and when the teacher left the desk or computing area, the students continued to share their newfound learning with others.

The teacher was able to maintain control of his dual classroom setting during game play sessions. The teacher stood in the classroom doorway and used it as a gateway between the in-class learning experience and the open student quad where the computing quad was located. He offered continual, positive support for the learning taking place; and he maintained a calm demeanor, appearing to reach out to students. Students immediately seemed to return to the lesson if they strayed. The teacher always had positive feedback even when a student clearly was not trying. He would ask the student, “Why didn’t you do this last night . . . let’s move forward and try this [problem] then” (Teacher A, personal communications, October 25, 2007). When needed to fortify the lesson, the teacher would often sit down next to students and ask, “OK, so how did you get this? Good! So, if we have that, use your calculator [if you need] . . .” (Teacher A, personal communications, December 13, 2007). This type of collaboration continued throughout the term. This teacher was able to work with individuals as needed but was also attentive to the large group issues related to in-class time and game implementation concerns.

Implementation Concerns

During the course of the 18-week term, the middle school experienced implementation issues and was not able to make the game fully active until the third week of the study. Additionally, the vendor expected to deliver an online educator portal to assist with game implementation. This, too, was delayed and was not functional until the second 9-week term. However, once delivered, the portal proved to be not particularly helpful. The teacher rated the educator portal as useless since it did not provide “detailed [pause] student information”

(Teacher A, personal communications, December 13, 2007). He commented further, “basically [the portal] just gives you their [students’] overall performance like you would see on this when a student looks at their performance on their profile . . . but, um, I need more detailed [information] by the mission” (Teacher A, personal communications, December 13, 2007).

Due to time constraints placed on the teacher to incorporate national and local standards in a very time specific manner, the teacher did not use educational video game in an organized or mission format as expected. Both teacher and student alike confirmed the lack of game play. One student noted, “I didn’t play [the game] a lot because I didn’t get most of my work done” (Student Cohort B, personal communications, December 13, 2007). The teacher on the other hand was more concerned with educational standards and time as he stated, “I don’t have that time to use [the game] right now, but hopefully after we come back at the end of the grading period, I’ll be able to look at my schedule and manage more time for them to get . . .” (Teacher A, personal communications, October 25, 2007). Clearly, time was a factor as the majority of those students interviewed confirmed “they played the game very little” (Student Cohort B, personal communications, December 13, 2007).

Furthermore, the researcher noted during her observations that the teacher did not use a specific mission order throughout the term. The teacher instructed students to simply start at Mission 1 and follow the program until the next Mission began or the time for game play had ended. In addition, students played the game as a reward immediately following the completion of in-class assignments. However, students had to raise their hands to gain permission to leave the room and go into the computing quad since the game play environment was contained in another room. In these instances, students who left the classroom appeared very happy to be able to play the game.

Ultimately, as the semester continued, time and curriculum alignment would be the enemy:

> Just time, just having time to take away from lessons and teaching being able to do that . . . now that we've kind of went through them [missions] a little bit more and I've used them, I can fit them into the lessons ah, a little more seamlessly. Instead of saying, "Oh we're going to go play the game today, it's [going to] be like, We're going to work on . . . adding integers, we're going to use the game" (Teacher A, personal communications, December 13, 2007).

Familiarity with the game appeared to be the teacher's best assistance for managing both time and implementation concerns. The teacher stated, "I think now that we've used it I can use it more as a motivator now that it's in place I'll be able to get to it at the very beginning and that'll help . . . as we go through as opposed to trying to squeeze it in later on" (Teacher A, personal communications, December 13, 2007).

As the study progressed, however, the teacher's motivational rating decreased from "positive effect" to "some positive" by the end of the study. Although the teacher did confirm integration concerns, he still viewed video games as beneficial to student learning as he additionally confirmed "7th grade – [using this particular treatment] would be a high correlation [to standards]" (Teacher A, personal communications, December 13, 2007). His focus remained upon time, access, motivation, and content relevance for the application of these games in his classroom.

Regardless of these concerns, it appeared the teacher's positive belief in the use of these tools prevailed over implementation barriers. The teacher continued to support game play and expressed positive feelings about the use of video games until the very end of the study. He indicated that he already had begun to look at another innovative game for use in his next year's classroom. He and his students had many suggestions, however, for future game designs.

Design Suggestions

Table 11 summarizes the believed game implementation barriers and suggested game development recommendations from a teacher's perspective.

Table 11.
Teacher Game Implementation Barriers & Development Recommendations

Person	Barrier	Gender Difference During Play	Observed Difference (m=males; f=females)	Game Design Requests/Need
Teacher A	Time	Y	1. Quicker (m) 2. Confident (m) 3. Need Time for Comfort (f) 4. Attitude Changed Over Time (f)	1. Better Course Alignment 2. More Integration Time 3. Mirror Order of Instruction in Text

The teacher stated, “They need to tie . . . he ability to be able to stun [shoot] other players to score points . . . there are too many kids that would run around and stun players and not really try to do the math. So if they can’t stun anybody until they do some math, they may have a greater urge to do the math” (Teacher A, personal communications, October 25, 2007). Regarding correlation to the standards, this particular treatment “doesn’t coordinate as well to the curriculum [as much as it did] with the first semester” (Teacher A, personal communications, December 13, 2007). It was viewed as more difficult to use an educational video game in the classroom when the technology does not align as affirmed by this teacher for this study, “I don’t think there will be as many opportunities to integrate it [the game] into your lessons, so it becomes part of your instruction” (Teacher A, personal communications, December 13, 2007).

Further, this particular treatment appeared to overstep its grade level boundaries for instruction. According to the teacher,

> For 7th grade, the first mission . . . fits the end of the year, but after the first mission, it kind . . . goes beyond the scope of 7th grade . . . the mathematics is more of an 8^{th} grade level or a pre-algebra level as opposed to a 7th grade level . . . to take time out to do missions that are material that you’ve covered already, may not be a priority . . . you’re only going to want to do missions that . . . fit with what you are teaching so you’re not wasting time (Teacher A, personal communications, December 13, 2007).

Of the seven students questioned concerning game design, a majority (n=5) agreed they enjoyed video game play more than traditional course work assignments. During the interview process, it quickly became apparent that these students had previous exposure to several types of video games during their schooling. Due to this exposure, many students started to compare the treatment to that of the previously played video games of Fast Math, Accelerated Math, and Gizmos. Having five of seven students agree that video game play was a preference indicated that traditional methods may no longer hold student interest to the extent that games can. Ironically, half of the interviewed students felt that “playing the single-player version helped to increase math skills” (Student Cohort A, personal communications, October 24, 2007; Student Cohort B, personal communications, December 13, 2007). Although students stated that learning to play the game was “very easy” for all interviewed students, complaints were voiced. Some students felt “it was hard figuring out the keys, [or] which buttons to press . . . how to move, and [some] had to figure out how to walk” (Student Cohort B, personal communications, December 13, 2007).

Table 12 and Table 13 present an overall summary of the suggested improvement in video game technology made by the student cohort from interviews. Technology appeared to skew student acceptance of traditional teaching methods and video game content that was not truly creative. Additionally, students voiced their dislike of scantrons and words problems by stating, “I didn’t like the paper thing to bubble things . . . [or] the mathematics book . . . questions, like, [student x] went to the store and bought . . . three candy bars for [student y] then [student z] (Student Cohort B, personal communications, December 13, 2007). Table 12 and Table 13 also presents the unified student views from the 1st and 2nd nine-week periods regarding game design suggestions, likes, and dislikes, as well as, the changes in student view point between interview periods.

Table 12.
Student Gaming Likes and Dislikes 1st Nine-Week Matrix

Person	Likes	Dislikes	Gender Difference (m=males; f=females)	Game Design Requests/Need
Student Cohort A (n=5; m=3, f=2)	1. Shooting 2. Killing 3. Cartoons 4. Walking 5. Jumping 6. Exploring 7. Sounds 8. Graphics 9. War-type Games 10. Rating: Liked Somewhat=3 ; Neutral=2	1. Graphics 2. Dying Every Second 3. Dying Too Quickly 4. 30 Second Reset Time 5. Game Lag 6. Game Glitches 7. Game Freezing 8. Slowness of Saving	1. Males Play Video Games More (m) 2. Males and Females Like Different Games (m; f – disagree) 3. Girls Don't Like Shooting Games (m; f – disagree)	1. Make Graphics Better 2. Create and Allow More Weapons 3. Use Different Worlds 4. Use Bigger Worlds

Students did however appreciate the ability to create and stay active while learning, but found the simplest game additions or removal of weapons or tools to be annoying:

> I like the adventure of it you can run around and you can shoot people . . . I disliked the graphics . . . [I do not] like [when] you die to fast . . . I want to fly. I want sport games . . .

> hate the most [in the treatment] is the fireflies, or whatever [they are called], they're all just flying around and they jump out of nowhere . . . I like the jet pack but you don't keep it the entire time . . . It was like one mission-- you have it and the next mission it's gone . . . Yeah, like the weapons . . . bigger weapons . . . we could customize the way they look and all that stuff (Student Cohort B, personal communications, December 13, 2007).

In total, shooting, war games, and character creation were high on the list of student acceptance. However, in the end, time spent away from the technology such as "lag in the game and the freezing, or when they [the game character would] die too quickly and [the student would] have to wait to return for 30 seconds" (Student Cohort B, personal communications, December 13, 2007) presented a universal game design "no-no" in the eyes of the students. Students also shared sex difference play and preference needs that presented an altogether different set of educational video game design concerns.

Table 13.
Student Gaming Likes and Dislikes 2nd Nine-Week Matrix

Person	Likes	Dislikes	Gender Differences	Game Design Requests/Need
Student Cohort B (n_{males}=2)	1. Shooting Things 2. Sounds 3. Rating: Liked A Lot (n=2)	1. Dying too quickly	N	1. Add Flying 2. Create More Sports Games 3. Add Jetpacks to Characters or Weapon Choices 4. Customize Game

Game Play and Preference Observations

The following introductory paragraphs provides an overview of the sample with regard to (a) ethnicity, (b) home personal computer (pc) ownership, (c) computer frequency/utilization, (d) computer self-assessment, and (e) game play habits.

As seen in Figure 8, ethnicity demographics showed similar background data (White $n_{females}$=12, n_{males}=15; African American $n_{females}$=9, n_{males}=8); Hispanic $n_{females}$=6, n_{males} =7). Two females reported their race as “other.”

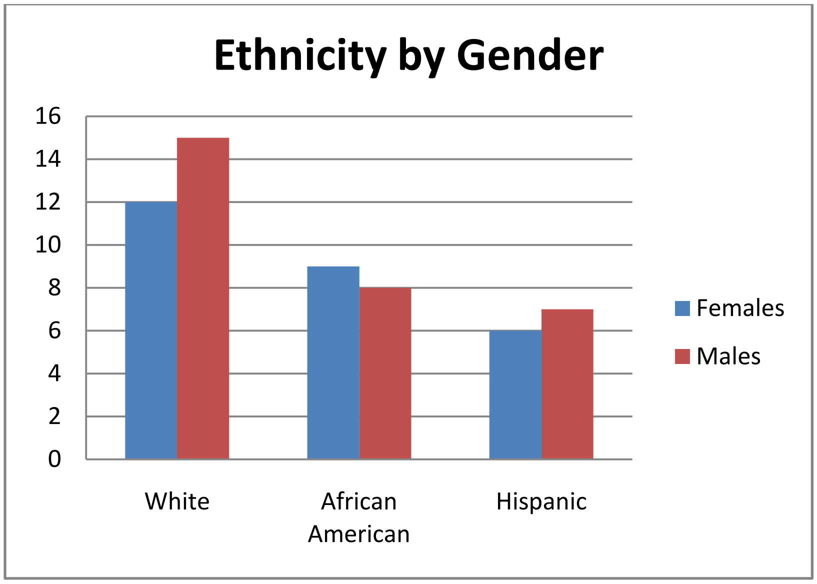

Figure 8. Ethnicity by Gender

Figure 9 displays information on home pc ownership. Home ownership was almost identical for the males and females ($n_{females}$=20, n_{males}=21).

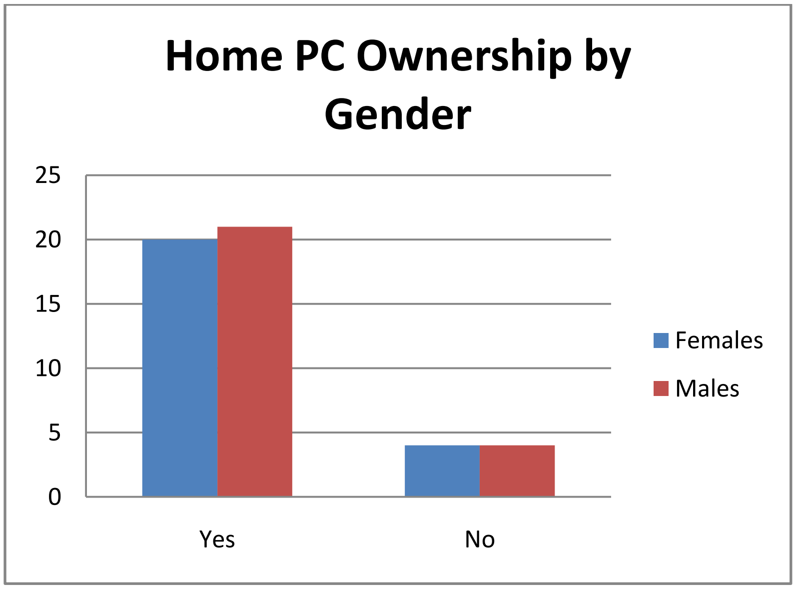

Figure 9. Home PC Ownership by Gender

As seen in Figure 10, females reported having similar computer frequency/utilization levels in the areas of “not often” ($n_{females}$=13, n_{males}=9) and “not at all” ($n_{females}$=6, n_{males}=3). There was a slight difference in computer frequency/utilization levels in other areas of “4-6 times per week” ($n_{females}$=3, n_{males}=4) and “1-3 times per week” ($n_{females}$=2, n_{males}=7), as well. However, only males reported using the computer everyday (n_{males}=3).

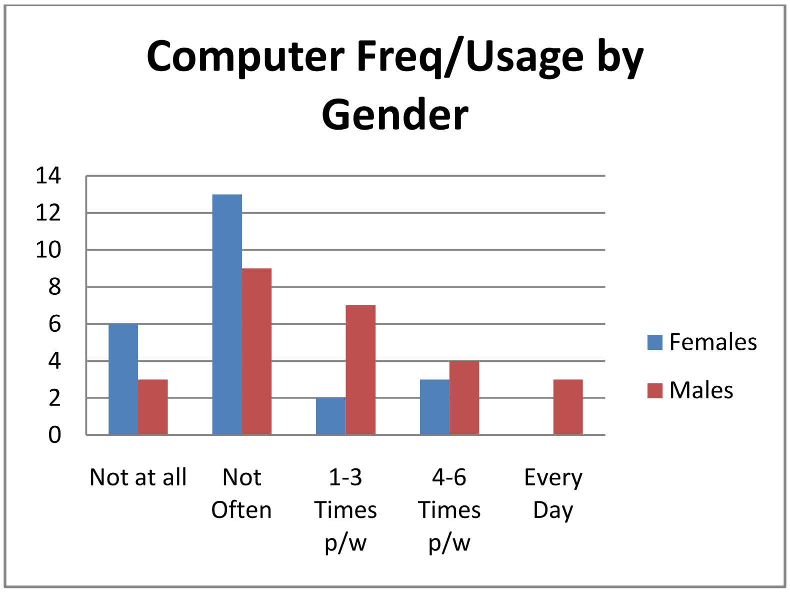

Figure 10. Computer Frequency/Usage by Gender

Figure 11 presented the self-assessment by students as to their classification of computer skill level. Within Figure 11, females ranked themselves equal or higher than males within the top two computer skill self-assessment areas of “Power User” ($n_{females}$=7, n_{males}=5) and “Proficient” ($n_{females}$=10, n_{males}=10). Additionally, females reporting having less “Novice” users ($n_{females}$=3, n_{males}=8). Oddly, no males addressed their computer skills as “Beginner” ($n_{females}$=5, n_{males}=0), but labeled themselves as “Non Users” ($n_{females}$=0, n_{males}=3) instead.

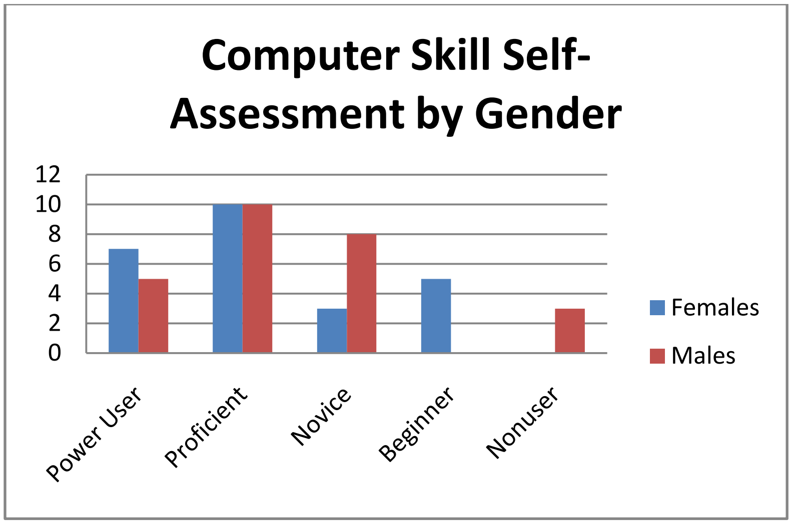

Figure 11. Computer Skill Self-Assessment by Gender

The self-assessed game play habits between the sexes are presented in Figure 12. Females reported higher levels of game play frequency throughout the week, reporting they played either "3-5 times a week" ($n_{females}$=3, n_{males}=1) or "1-2 times a week" ($n_{females}$=4, n_{males}=4). Only males reported as playing games "Every Day" of the week ($n_{females}$=4, n_{males}=6). Oddly, more males reported they did "Not [play] Often" ($n_{females}$=7, n_{males}=12) with this category hosting the highest number of overall sample students. Further, females reported having a higher number of members who did "Not [play] At All" ($n_{females}$=6, n_{males}=3).

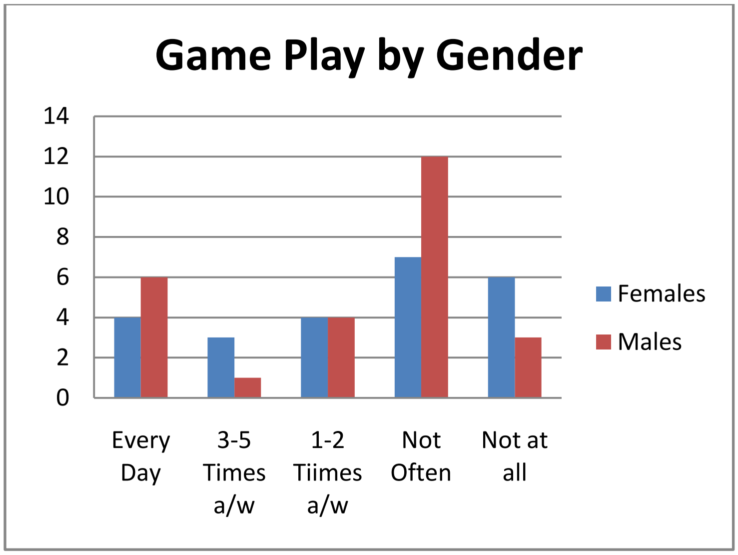

Figure 12. Game Play by Gender

Throughout the interview process, males verbalized their views more than females. Males also presented reasons as to why they felt there were differences in game play between the sexes. When asked about their personally observed sex differences in game play and preference, male interviewees began the interview by stating "girls lack playing [skill], girls like instructions and don't like . . . shoot 'em up games," (Student Cohort A, personal communications, October 24, 2007). One boy stated, "girls aren't interested in the same type[s] of video games that boys are interested in" (Student Cohort A, personal communications, October 24, 2007). Another boy immediately mirrored this opinion by saying, "I'll play anything, but sometimes girls don't like to play those games where you have to shoot at people" (Student Cohort A, personal communications, October 24, 2007). Both researcher and teacher, in their observations, concurred with this casual untrained male observation.

The teacher stated, "boys [are] quicker to play [and females are] slower to embrace games but built confidence as the game play continued" (Teacher A, personal communications, December 13, 2007). This statement supported the data found in Figure 12. Although sex differences were observed by the teacher with regard to girls having a lack of interest compared to their male counterparts, the teacher tended to find overall sex differences to be minimal in terms of comfort level between the sexes when using educational video games and innovative tools in the classroom (Teacher A, personal communications, December 13, 2007). The teacher believed that sex difference was irrelevant over time:

> Um, I think the boys [stresses] buy in quicker . . . But I've had, and I'm basing this on my last year, I had girls tell me that they did not like the game. They did not want to play, but then would play on free time, so their attitude changed. In the beginning, I don't want to play, I don't want to play [pause] and then after a couple weeks after having moments where they've played, then they started playing more. Although they weren't as quick to buy in, "I want to be part of this," but they actually liked it as they actually started to keep going (Teacher A, personal communications, December 13, 2007).

The teacher and researcher observed that the longer females stayed at the screen the easier it appeared to be for them to ask questions and the more likely they were to move beyond the initial confusion of the tool. According to the teacher, "I think they were intimidated at first because the boys were so [stresses word] into it, like, 'I can play videos,' and they [females] were not sure about their confidence level in it. So they played a little bit and they realized it isn't that difficult to play a video game" (Teacher A, personal communications, December 13, 2007). The teacher additionally felt that of the females who did play video games, many females were lacking multi-play video game play as he stated "third person play [of] video games [that are used] on [the] computer" (Teacher A, personal communications, December 13, 2007). Further, he stated:

> [Males] play Halo, and they play Metal of Honor and Call of Duty, and so those games [pause] fit the style of play of this game [the treatment], especially if they play on PC. Call of Duty, Metal of Honor, and those kind[s] of games, are in the exact same style of play. I think overall the boys picked it up faster but then I think the girls [felt], ur, [pause] balanced out . . . I [simply] don't think they played as many of these type games, style games before (Teacher A, personal communications, December 13, 2007).

When the teacher was asked directly about gender and game play comfort, the teacher stated "Only at first do the boys feel more comfortable, but only at first" (Teacher A, personal communications, December 13, 2007).

Students were also asked a follow-up question directly related to game type preferences between the sexes. One female student, in particular, voiced her opinion strongly, stating she "didn't have a preference" (Student Cohort A, personal communications, October 24, 2007). However, this particular female stated her preference did not matter because "[she didn't] have time to play video games that much anyway" (Student Cohort A, personal communications, October 24, 2007). She did not elaborate as to why she did not have that much time available. Conversely, males felt there were "more video games that contained shooting" (Student Cohort A, personal communications, October 24, 2007). All interviewed students for the 1st and 2nd nine-week periods agreed (Student Cohort A, personal communications, October 24, 2007; Student Cohort B, personal communications, December 13, 2007). Oddly, one male appeared disappointed in the alternative to shoot 'em up games by saying, "If it's not a shooting game then it's cartoons like Mario" (Student Cohort B, personal communications, December 13, 2007), and he rolled his eyes. Despite the verbalized differences noted during interview sessions, there were also hands-on differences observed during video game play.

During the second observation period, there were six students playing the video game in the quad. Of these six, only two females were playing the video game. Both females appeared to be having trouble either loading the game or starting the game. However, this appeared to be more of a lack of computer knowledge rather than video game play since it happened at the onset of starting the video game. One girl put her head down on the table after a very short period of trying to start the video game and appeared tired. The teacher came into the quad from the classroom and asked her what she was doing. The student explained she did not even get to the game yet but stated she had been trying for five minutes to start the game. When told by the teacher to return to the classroom, this female student did not appear to mind. However, the remaining female immediately spun around in her chair to ask for help. Once received, this female quieted down, appeared to play the video game with greater ease, and started moving faster through the mission. However, she, too, spent more time attempting to figure out the controller than playing the video game. She ultimately returned to the classroom prior to the end of the time allotted for game play.

Conversely, males appeared to have great fun collaborating with each other about the video game's mathematical content. One interaction witnessed involved one student asking another "what equals 63?" (Student Cohort B, personal communications, December 13, 2007). This same student asked another student to look at another area of the game for pure interest. Males also appeared very intent on playing the video game without question, whereas females appeared to read all video game directions thoroughly. When asked if sex differences are obvious, the teacher responded, “I don’t know if I would make a distinction between any of them, but just in general they want to be able to do well at the game so if they don’t have the skill they want to know what the skill is ‘so I can become skillful’” (Teacher A, personal communications, December 13, 2007). Lastly, when boys were told they had only two minutes left to play the video game, they asked if they could stay longer.

It was somewhat difficult to monitor in-class and quad activities while students played the video game at the computing stations. The teacher was able to visit between both rooms with ease. He simply used the door to the classroom as a gateway for one-on-one question and answer sessions between rooms. In one instance, rather than discipline a student for talking loudly in the gaming area, the teacher simply ignored the situation and attempted to maintain rapport with everyone in the two areas without creating a larger distraction. The games appeared to take a long time to load (approximately two minutes). During that time, the teacher was accessible to troubleshoot any issues that arose. Within the constraints of a 51-minute classroom period, this loading or start-up issue appeared very distracting to the learning atmosphere.

When playing the game, students wore headphones to reduce quad noise but occasionally, a student would remove the headphone jack and allow the game’s music to fill the quad. In these instances, classroom outsiders, who were walking to their lockers or the bathroom, would stop and watch others play the game for a moment before returning to their class. One student really liked the music and kept disconnecting the headphones so that the computer would play the sounds. Once reconnected, game sounds could still be heard from the headphones, indicating the sound was set to an abnormal listening level. Clearly, this student was enjoying the video game's music. Musical enjoyment aside, it was the educational benefit that was being overlooked by students according to the teacher, "I don't think they've [the students] used it [treatment] enough to have an impact yet" (Teacher A, personal communications, December 13, 2007).

CHAPTER FIVE: DISCUSSION

Using the CHAT framework as a lens for exploration of topic, Chapter Five discusses the research results presented in Chapter Four as they support or reject the stated study hypotheses. Chapter Five further situates data findings in relation to the empirical evidence presented within the literature review found in Chapter Two. Therefore, the following headings were used in organizing this chapter (a) Statistical Findings, (b) Examination of the Dual Activity System, (c) Future Implications, and (d) Recommendations for Future Research.

Statistical Findings

The purpose of this research study was to examine educational video game effects on mathematics achievement and motivation between sexes within an experimental research design utilizing a mixed-method analysis. In addition, the goal of this dissertation, through variable exploration, was to inform instructional and commercial game designers, educators, and administrators of the many differences that need to be considered when implementing educational video games in K-12 classrooms. The study was conducted to examine sex difference within a 7th grade mathematics classroom ($n = 60$) learning algebra to discover attributes relating to educational video game play, preference, setting, and items otherwise viewed as barriers to learning within modern day gaming literature (Agosto, 2004; Dickey, 2005; Valenza, 1997).

Academic achievement and mathematics class motivation outcomes were analyzed using a repeated-measure (SPSS, v14) test. The analysis included ethnographic results from both student and teacher interview and observation sessions for data triangulation. Although missing data and lack of consent ($n = 57$) produced a sample size of 60, the sample size was deemed appropriate for analysis when utilizing a repeated-measure examination as indicated (Glesne, 2006).

Research Questions 1 & 3

Research Questions 1 & 3 examined academic mathematics achievement when using an educational video game as a treatment for learning algebra. Research Question 1 considered differences, if any, in academic mathematics achievement scores between sexes when using an educational video game as an in-class tool or media.

> Question 1: Are there differences in academic mathematics achievement scores between sexes when using an educational video game as an in-class tool or media?

Whereas, Research Question 3 inquired as to whether academic mathematics achievement scores changed when using an educational video game to learn algebra.

> Question 3: Does academic mathematics achievement score change when using an educational video game to learn algebra?

Significance was found with regard to academic achievement score from pre to post testing. However, academic achievement scores did not report significance between the sexes. Although it was not investigated in this study, future studies should examine if game play had a direct effect on achievement score by examining both the treatment and control groups of the experimental study. The following data and discussion provide support for this statement.

There was a statistically significant increase between pre and post testing of academic achievement scores ($F=21.8$, $df=1, 54$, $p<.05$). Findings in the present study supported the majority of empirical evidence (Annetta, Mangrum, Holmes, Collazo, & Cheng, 2008; Blunt, 2006; Jones & Kalinowski, 2007; Pinder, 2008; Reese, 2007; Sedig, 2008; Squire, 2004) with regard to positive achievement outcomes.

There was no statistically significant difference between female and male academic achievement scores when using an educational video game as an in-class tool although males did report higher initial mean scores as compared to females. Thus, the findings in the present study supported the Hyde et al. (1990a) meta-analysis findings which indicated a "slight" difference in scores existed between the sexes. Though there was a difference, however, female academic achievement scores did not differ statistically, as males did not outperform females or vice versa.

Findings of the present study confirmed that the usage of in-class teaching in conjunction with the utilization of the educational treatment (use of video game) improved the learning environment, as achievement scores did significantly improve during the 18-week term while using the treatment.

Findings also mirrored the empirical findings with regard to playing games in a social setting. The social context of the game play allowed for further exploration of the video game's potential by females and provided a learning opportunity for female students to construct their own active meaning of the situation (Halttunen & Sormunen, 2000; Hamalainen, 2008; Prensky, 2001a). Females were able to form a new relationship with technology and understanding of the activity (Kafai, 2006) as indicated by the participating teacher. This observation further supported Jones' (2007) statistically significant finding regarding achievement scores when games are played in a social collaborative atmosphere. The application of a constructivist type of lab setting, in this case an open computer quad used for video game play, did not restrict social dialogue (Braun et al., 2001; Jones, 2005).

The open lab setting supported empirical evidence relating to the social needs of females in order to be productive in learning situations (Damis-Paraboschi et al., 2005; Valenza, 1997). Usually, video game play is viewed as an individual activity (Gee, 2003). However, the video game play setting, as described in Figure 7, within the current study allowed for the inclusion of social aspects and provided females with a method for building upon innate socialization habits not otherwise identified with males (Damis-Paraboschi et al., 2005). In turn, females were successful at video game play over time as reported by the teacher.

Furthermore, verbal and socialization activities “provide[d] simulated interpersonal gains as reinforcement” (Braun et al., 2001, p. 541). The game-play environment, as described in Figure 7, also created an atmosphere, an experimental learning environment, perfect for female engagement (Annetta et al., 2008). Additionally, the dual-activity system did not require prior knowledge for the game play. Only socialization techniques were needed to learn to play the game. Therefore, students with limited prior exposure to games were exposed to mathematics concepts, since the treatment aligned to that of local and national mathematics standards. Additionally, the video game play activity supported students who were missing previous exposure through a contextual setting, that of an open lab setting, as shown in Figure 7.

The experimental learning environment did not require prior knowledge of video game play. This directly conflicted with the empirical findings of Reese (2007). Reese stated females are at a disadvantage due to the lack of game play exposure. However, of the females surveyed and as seen in Figure 12, participants openly reported playing video games; thus, student personal views directly negated empirical evidence regarding the lack of video game exposure. An oddity, however, existed between of the self-reported computer and gaming play habits found in Figure 10 and Figure 12, to that of the self-reported student computer proficiency ratings, as seen in Figure 11. Students reporting as begin "Proficient" in computer utilization. However, a high percentage of students reported as either not playing video games or using the computer often which presented an inconsistency as to how these students obtained their proficient computer knowledge. Nonetheless, this finding additionally negates the literature with regard to differences between the sexes as males and females equally reported having not played video games before. Additionally, as seen in Figure 12, half of the females surveyed reported playing video games either 1-3 or 2-4 times a week, whereas, males stated they played video games every day. This finding supported a difference in game play habits. However, this difference was not overwhelming as reported by ESA's 2007 gaming demographic report (Entertainment Software Association (ESA), 2007). Even with this slight difference in game play habits, there was no apparent hindrance caused by lack of video game exposure that was witnessed by the researcher or reported by the participants. Female engagement increased as game play continued over time, and was verified through teacher observation and statistical findings. Female exposure to mathematics content through video game play was considered equal to that of male participants. This provided further support for the increase in achievement scores from pre to post testing when used in conjunction with in-class teaching methods.

Conversely, some evidence has been produced suggesting that video game play without structure becomes trial and error to students and until the trial and error period has ended the availability for repurposing of a playful game to one for learning is non-existent (Squire, 2004). However, the statistically significant findings in the present study indicate otherwise since achievement scores were not stagnant and presented an increase. Regardless of the previous empirical inconsistencies found with regard to educational video games for learning, the results found within this study indicated that using educational video games in a social setting in conjunction with in-class teaching methods has a positive effect upon academic achievement scores.

The current study has resulted in a contribution to the literature for sex difference and educational video game effectiveness by: (a) utilizing a mixed-method data analysis, (b) examining 7th-grade, which is the grade level, identified as presenting mathematics scores changes between the sexes, and (c) examining a commercial video game created with standard alignment in mind. The present study has resulted in new findings regarding female-gaming habits and game play exposure needs. Although portions of this study's finding mirror those previously reported in the literature, this study additionally adds an in-depth exploration of a dual-activity to the literature in which positive findings were reported.

Research Questions 2 & 4

Research Questions 2 & 4 were used to guide the investigation of motivation when using an educational video game as a treatment for learning algebra. Research Question 2 was used to examine differences in motivation scores between sexes when using an educational video game as an in-class tool or media.

> Question 2: Are there differences in motivation scores between sexes when using an educational video game as an in-class tool or media?

Whereas, Research Question 4 sought to determine whether motivation toward mathematics class change when using an educational video game to learn algebra.

Question 4: Does motivation toward mathematics class change when using an educational video game to learn algebra?

Findings did not support a difference or a change in mathematics class motivation either between the sexes or from pre to post testing. The following data and discussion provide support for this statement.

Mathematics class motivation scores did not present significance either between the sexes ($F=.37$; $df=1, 47$; $p>.05$), or between pre to post testing ($F=.79$, $df=1, 47$, $p>.05$). There was, however, an equivalent outcome between the sexes with regard to mathematics class motivation after using an educational video game as treatment during the 18-week term. However, the findings were interpreted with caution as this activity was situated in an open lab setting and motivational outcomes with regard to educational video game utilization were not collected due to the dual nature of this activity.

The treatment used in this study was an educational video game developed in mission-based format that had been aligned to local and national mathematics standards. Due to normal housekeeping tasks at the beginning of every school year and software/hardware implementation issues, the start of the video game play activity was delayed. Although video game play expectations did not include sequential mission-based play, the assumption did include weekly video game play that mirrored weekly topics in order for students to make the connection between algebra learning and the treatment. Due to in-class time constraints and curriculum concerns, however, the video game play activity was reduced to a drill and practice offering.

It was not assumed that mathematics class motivation would result in a lack of significance with regard to mathematics class motivation or toward the Game Play activity, since the game play activity was completed outside of the learning classroom and since social settings have been known to contribute to positive outcomes (Amory, 2007; Damis-Paraboschi et al., 2005; Halttunen & Sormunen, 2000). It is possible that the disconnect between game play setting and that of the in-class learning atmosphere affected mathematics class motivational outcome since motivational scores did not present significance. Oddly, the teacher's perception of the video game's correlation even diminished overtime making the lack of significance in mathematics class motivation hardly a coincidence. Conversely, students may have simply mirrored the teacher's declining attitude about the game's ability to support in-class alignment or because of a lack of structured implementation and video game play. However, no additional examination was conducted since significance in motivational difference was not found.

Mission-based play was foregone in support of game play as a reward or drill and practice support. Students who would finish their in-class work early were allowed to participate in the game play activity. Game play took place outside of the learning classroom, and that created a disconnect between video game play and in-class learning activities. Mission-based play was additionally reduced to resuming play where students had stopped in previous play. Flow of game play was, thus, interrupted and created a barrier to learning (Sedig, 2007).

The disruption of flow or lack of structure in game play affected individual motivation areas somewhat differently for males and females. The ill-structured video game play may have contributed to the lack of significant with regard to mathematics class motivation (Sedig, 2007) since both teacher and students supported and prefer educational video games as media compared to regular in-class assignments and activities and reported during interview sessions.

Additionally, the lack of game play may have contributed to the overall results as well, since the mathematics class was viewed differently.

Clark (1999) believed that motivation examined tool usage in relation to tool mastery. Therefore, one can only deduct that a lack of game utilization caused the lack of significance in mathematics class motivation, as students did not spend enough time with the game for mastery, this, in turn, game play was highly expected component in such a technologically enriched school and motivational outcomes are one with mastery of tool in this limited instance.

Research Question 5

Research Question 5 was focused on the observed differences in video game play environments by sex.

Question 5: What are the observed differences in video game play environments by sex? The observed and communicated sex differences were minimal as the data presented a unified view of gaming needs and wants. Males however expressed a skewed view of female game play and preference needs in which females disagreed. In total, (a) shooting, (b) war games, (c) character, and (d) game world creation in conjunction with game customization requests were high on the list of student game acceptance. Furthermore, time spent away from the technology caused from a lack of structured implementation in conjunction with in-play gaming issue, such as (a) lag time, (b) failed game start-up, or (c) character dying and resurrection time lengths, presented barriers to game utilization and tool repurposing. Additionally, the perceived barriers to game play were identified as universal game design “no-no” by all students interviewed. Lastly, there appeared to be no glaringly gender-based differences in gaming needs by either sex as all students shared a unified listing of game play and preference needs. Although this data was gathered using a limited sample, the data presented an altogether different set of educational video game design concerns different from the literature. Thus, these data allowed the researcher to add to the empirical literature concerning video game play and preference needs between the sexes. The follow data and discussion provide support for these statements.

Due to the mixed-method nature of this study, qualitative data was used to examine the complexity of the dual activity system designed to aid students in learning algebra. The activity system was examined from the vantage of the smallest unit contained within the system to examine for interaction using a hypothesized version of Cultural-Historical Activity Theory (CHAT). CHAT provided a framework to reveal what worked and what did not work within the system in terms of transformation (Barab et al., 2002; Engestrom, 1987). “It is through understanding these relationships that we can identify possibility of change and opportunities for fruitful lines of research” (Fiedler, 2006, p. 212). Thus, the discussion, which follows, presents the overarching themes found during interview and observation sessions, which rejected or supported the empirical evidence and established a relationship between the quantitative data and the CHAT framework.

As confirmed by participants themselves, found in Table 12 and Table 13, findings showed there were no real or obvious differences in educational video game play between the sexes. Furthermore, males and females share similar beliefs that video games are a preferred learning method. However, participants did present differences with regard to structured video game play and video game design requests also shown in Table 12 and Table 13. During interview data collection, a difference existed that includes tool customization of (a) game, (b) characters, (c) worlds, and (d) weapons as reported in both Table 12 and Table 13. Females want more customization of character and color, whereas, males simply wanted more customization of weapons. Both groups did agree that playing in additional worlds would be a positive attribute and asked for more time to play. Oddly, males believed girls do not like shooting games; females disagreed. Nonetheless, the teacher observed statements do support that females, as well as, males all do play video games. However, the teacher did state the one difference is that females need more time to "warm up" to the situation.

During the second round of interviews, the students in the cohort voiced their dislikes for some aspects of the game play design, which served as a distraction. Females stated they wanted more colors. Males indicated that the game sounds and flying insects were bothersome to them during their video game play experience. These dislikes appeared to become barriers to game play and contributed to the lack of significant mathematics class motivation.

The qualitative findings reported in the literature were very much the opposite from those reported in the present study. Male participants made mention that females do not like shooting games. However, females who were surveyed did not concur as reported in both Table 12 and Table 13. Furthermore, females additionally disagreed that video game playing was a male-dominated task. Squire (2004) stated, "Too often game designers argue that girls are not gamers because technology-enhanced toys are boys' toys, girls are not into competition, or games don't appeal to girls… girls were turned off because they were not intrigued" (Squire, 2004, p. 394).

The student cohort and the teacher in the present study indicated equal likes and dislikes of the game as seen in Table 11, Table 12, and Table 13. Both the teacher and the students agreed that game play was a preferred learning method over traditional teaching methods. No additional comments were made regarding ill feelings toward a character's look and feel or overly violent gaming attributes (other than shooting) within this treatment's design; and, this supported the notion that this treatment corrected for previously assumed hypersexualized imaging. Neither statement showed support for the mathematics class motivational outcomes.

Furthermore, as expressed by Dickey (2005), Mubireek (2003) and De Castell and Jenson (2003), there existed a need for engendered game designs to appeal to the female audience. No student in the present research requested the need for a gender-neutral type of video game or game content, thus, additionally contradicting empirical findings that supported the utilization of gender-neutrality in video game design. Although this may have been true for the commercial games examined by De Castell and Jenson, no evidence to support engendered design was found in the present study. The data only presented findings concerning a lack of difference or change in mathematics class motivation when using a video game. Game design changes were requested which may contribute to the lack of significance with regard to mathematics class motivational outcomes. Additionally, students did state *competition* as a desired game feature but the teacher elected not to play the multiplayer video game portion of this gaming suite which may have satisfied this student need. However, data suggests there is no support for engendered video game design. Game design requests included: (a) more time to play and (b) gamer customization features for creating new worlds, character features, and tools.

Examination of the Dual Activity System

The complex system examined in this study was one divided between a classroom-learning environment and that of a social, yet open quad, educational video game play environment that encompasses two activity systems: (a) Math Lab and (b) Educational Video Game Play. The examination included the components of CHAT as they relate to this study. The components include: (a) subject (*students*), (b) object (*mathematics problems*), (c) community (*mathematics class versus an open computer game lab*), (d) instruments/tool/artifacts (*educational video game*), (e) rules (*teacher in-class versus video game play*), and (f) division of labor (*teacher as leader; students as learners versus students as equals with minimal guidance*).

CHAT's framework allowed for a critical examination of the changes introduced to the system that created tensions that either supported or failed the dual system (Fiedler, 2006). The present examination uncovered four areas of tension that caused change within the system (a) open computer game play lab setting (*primary tension*), (b) lack of student tool repurposing (*primary tension*), (c), unstructured game play (*primary and secondary tensions*), and (d) large time constraints (*primary*, *secondary and quaternary tensions).* Thus, these changes caused many changes to the dual activity system.

Due to the natural progression of the start of a new school year, the teacher delayed video game play and integration. In terms of structured planning, the teacher simply implemented the game by allowing students to start at Mission 1 and continue sequentially until the end of the term. Thus, the teacher abandoned mission-based alignment suggestions offered by the vendor. Video game play without structure became a trial and error activity for students. Until the trial and error period ended, student tool repurposing for learning was non-existent (Squire, 2004).

Through qualitative collection, both students and teacher indicated that time was a large deterrent to this study from an implementation perspective. During observation, however, the teacher used his video game understanding and personal gaming habits to implement the educational video game activity within tough time and curriculum constraints. Due to time, the video game play format was not conducted in mission format as originally intended per the treatment's video game suite design. The lack of implementation time, curriculum alignment to textbook and overall lesson plans, in conjunctions with the lack of gender tool repurposing, all added to the overall change to the dual-activity system, but the changes found of the system did not result in failings of student achievement. Time constraints involved (a) class introduction, (b) video game installation, and (c) normal teaching sessions, all of which contributed to the majority of changes associated with the study.

The teacher conducted video game play in the school's open computer quad. As seen in Figure 7, the game play environment could be described as a disjointed community located in a game play quad area adjacent to the learning classroom. This arrangement presented a challenge to student tool repurposing (Squire, 2004), since students were attempting to use the video game to learn algebra, and the teacher's time was necessarily divided between the two areas. Students played the video game without structure.

Additionally, the participating teacher noted only half of the missions within the video game single-player version were aligned to the course. The second half of the semester did not relate to chronological mission play. In fact, some missions were simply outside the scope of learning for 7th-grade content. Therefore, game missions were overlooked in terms of specific topic and help for learning, and became drill and practice events. This finding provided a rationale for the teacher's decision to resort to a mission-by-mission lesson plan rather than maximizing the video game content for learning as a unified tool. This change resulted in unstructured game play and caused the teacher to use the video game as a drill and practice type of medium rather than an integrated tool. There was no follow-up after game play to explore issues of the activity or the learning of algebra.

Pressures of the school district and national standards required the teacher to press on with standard lectures and classroom activities rather than implementing the educational video game as intended. “As long as there is any split between learning the game system and having meaningful educational experiences, there may be obstacles to designing educational games that rival their entertainment counterparts in complexity and their ability to engage [the] player” (Squire, 2004, p. 403). The teacher’s classroom setting and dual game play setting presented extraneous tensions leading to a heightened number of changes within the system which have not been previously mentioned in any other study reviewed, other than time constraints of the district.

Mitigation of a Failing Activity

The changes found in the dual-activity system identified an additional, yet intangible, activity system acting as a mediating activity, sometimes referred to as a boundary object (Goodall, 2004), interceding between the Math Lab and Educational Video Game Play activities, as seen in Figure 13. Thus, the environment was more complex than first thought and included a 3rd activity, the Teacher Activity system. The teacher became the primary source for students to understand the video game play, much like a boundary object would. This finding was congruent with that of Squire (2004) in his examination of Civilization III. The teacher understood if no time existed to learn the algebra content, the time was not appropriate to implement the game through mission-based play. Although the teacher in this study is not a tradition boundary object as described by Susan Leigh Star (as cited in Goodall, 2004), this teacher’s self-identified proficiency in video game play in conjunction with his many years of teaching experience, allowed him to act as a reference between the two activity system and provided the needed information much like a boundary object. He simply became a mitigating, yet, intangible bridge (MIB) between the two systems. This is further indicated in Figure 13. Initially, when asked how often he personally played video games, the teacher assumed the question concerned student in-class video game play rather than teacher personal play as if to overlook or discount his game-play habits. Ultimately, these skills would be the skills needed to mitigate the lack of structured implementation found in this study in order to help students succeed.

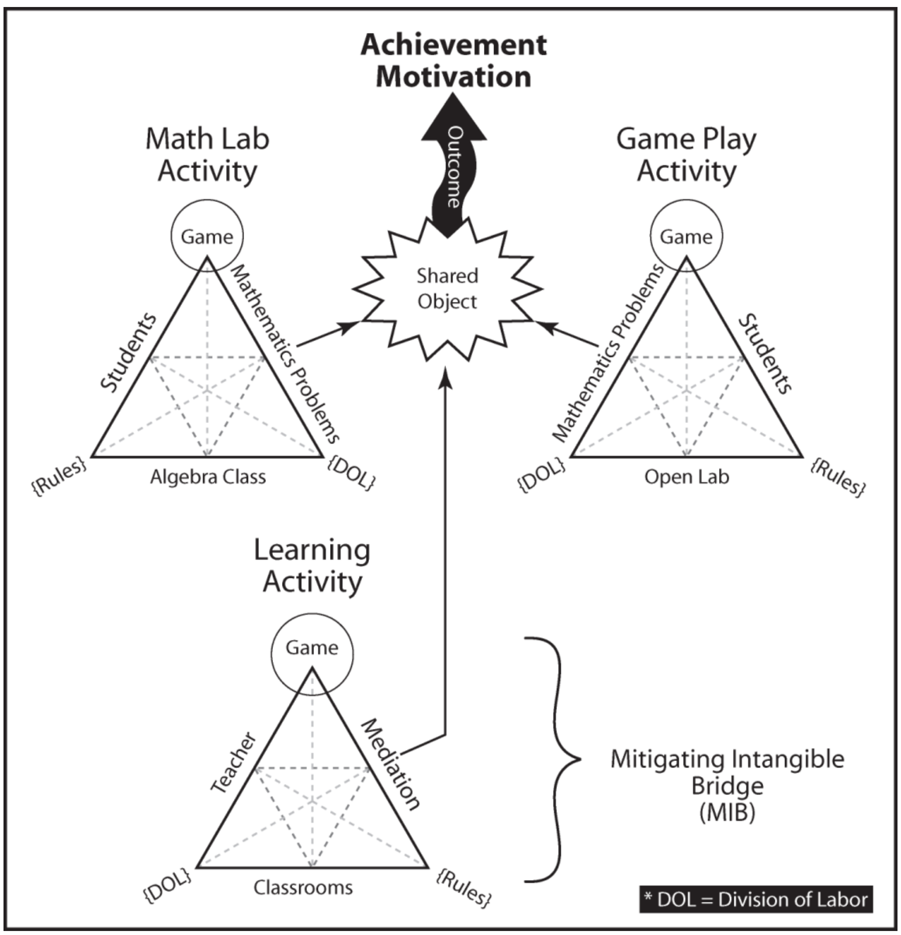

Figure 13. Mitigating Intangible Bridge & Boundary Activity Intercession

Ertmer (2005) found teachers who had positive perceptions of video games were most likely to use games in the classroom. No empirical findings, however, were discovered regarding

(a) teachers' positive perceptions in relation to their personal video game play habits, or (b) the correlation of teacher video game implementation success to that of personal gaming habits. Because previous studies have only examined correlations between teacher acceptance and in-class implementation success, teacher's video game play ability and implementation were of particular interest.

In examining the dual activity from the perspective of individual activities, the Educational Video Game Play activity overshadowed the Math Lab activity to some extent due to the unstructured nature. The duality was not between the Math Lab and Educational Video Game Play activities directly but existed between the Math Lab activity and the Educational Video Game Play activity through the mitigation of the Teacher Activity as seen in Figure 14. The Teacher Activity allowed the teacher to (a) demonstrate his ability to disseminate video game play knowledge, (b) share his self-identified extensive game play skills, and (c) understand his classroom limitations in terms of time, as demonstrated in Figure 14.

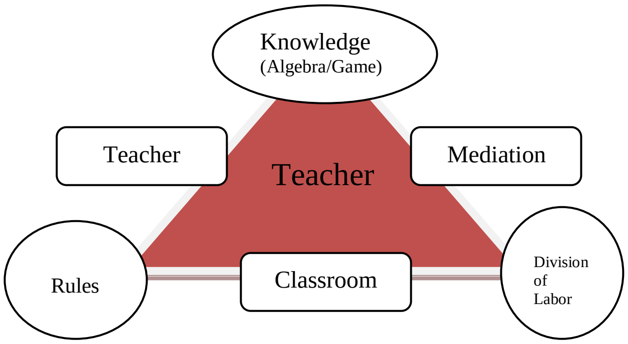

Figure 14. Teacher Activity

However, the teacher's intimate understanding of this particular game suite became a barrier to video game play mission-based implementation but supported the necessary facilitation of learning in this type of environment. The teacher simply understood what students needed to succeed at learning through a game play event. Rather than attempting a failed mission-based implementation to observe the interaction for outcome findings, the teacher, through no fault of his own, inadvertently allowed one activity to overshadow the other.

The researcher concurred with Squire (2004) who found that "the emergent nature of game play is also part of what makes gaming and simulation so interesting for both students and teachers, and as instructional designers, we need to be careful not to over prescribe or over plan activities so to kill the emergent learning that is part of the power of this approach" (Squire, 2004, p. 411). Thus, the emergent nature of the mitigating, or boundary, activity system produced the positive achievement findings and inversely affected mathematics class motivation since the treatment (educational video game) was not played as intended.

It was believed that this lack of facilitation led to the lack of significance for mathematics class motivation. Clark (1999) posited that when one measures motivation, one simply measures self-efficacy between tools and mastery. In examining this study's motivational outcomes based on the Clark definition, one can link both quantitative and qualitative findings to the strained tensions in the dual-activity system. Neither the increase of a system tension alone, nor the volume of changes found within one of the activities forming the dual system, can explain the lack of significance with regard to mathematics class motivation, or the increase in academic achievement score. However, when these activities are viewed as an interrelated component within a dual system, the relationship is understood.

Implementation problems resulted in an ultimately mitigated dual activity system. Even though the teacher knew the game, game play and curriculum alignment became the challenges since missions no longer correlated with the teacher's and school's specific order of instructions from the textbook. Although students were exposed to mathematics content through game play, the dual activity system was dormant in terms of repurposing since students errantly played the video game without follow-up exploration. Students then were only playing to play and were not held accountable for studying mathematical constructs prior to shooting the other players or exploring the game's topics. As with lesson plans, games and game play activities need purposeful planning and implementation. Without proper attention, projects will fail.

The lack of structured implementation did not produce a profound connection for students between video game play and algebra learning. This added to confusion between motivation for mathematics class and a mathematics class that contained video game play. Additionally, the limited exposure to the video game was only in terms of unstructured mission-based play. However, the significance of improved achievement cannot be overlooked. Even if a drill and practice event took place using the treatment, findings indicated that the utilization of the treatment in conjunction with in-class teaching ultimately led to a positive outcome. The activities were mitigated by the teacher, but students were mentally engaged (Sedig, 2008). The unstructured nature of video game play, however, prevented students from immersing themselves in the game play activity.

Although the treatment was not a complete failure in terms of video game installation and game play activities, activity system changes existed in an area of structured play causing higher than normal tensions in a dual activity system. Because of this, the game play activity could not be carried through as intended to test the potential value of the treatment within the overall system while learning algebra. A dual system was used to explain results, but it is important to discuss the overall results.

Future Implications

Replaying History (Squire, 2004) is arguably one of the most comprehensive studies of commercial video game usage in a K-12 history classroom. Squire discussed game complexity, implementation, functionality, and the use of activity theory to examine a commercial game for educational value. Findings in the current study supported the empirical evidence regarding commonality of purpose presented by Squire. Squire did not, however, investigate difference between the sexes as a primary goal to uncover educational video game play performance, motivation, and preference while using a dual-activity model.

This chapter has presented a summary of supportive and contradictory findings, along with matters of importance to the field of instructional design regarding differences between the sexes, educational video game design, and implementation for K-12 classrooms. Additionally, CHAT proved to be an invaluable tool for the investigation of a game play activity when used in conjunction with a math lab activity.

Instructional Designers who are looking to implement educational video games in K-12 classrooms need to be mindful of the time it takes to teach students how to play the game in order for students to appreciate the objectives of the game in relation to the topic to be taught. Squire (2004) referred to this understanding as repurposing of tools. An introductory lesson would allow students to overcome the learning curve associated with the learning of new tools. If creating mission-based video games, introductory episodes should be included in Mission 1 to help develop understanding of the conceptual topics of game play (Damis-Paraboschi et al., 2005; Tallir, Lenoir, Valcke, & Musch, 2007). Otherwise, the drill and practice nature of video game play will continue since teachers simply do not have the time in their lesson plans to teach their students how to play.

Based upon the data collected from both the teacher and the students regarding game design requests found in Table 11, Table 12, and Table 13, game designers should collaborate with teachers, book vendors, and students alike to create successful alignment of standards and curriculum, but need to address a teacher's personal plan for the course. Without proper alignment, teachers will be likely to overlook the true potential of video games as a supportive medium for learning.

Lastly, this study would be remiss if it did not summarize future implications specific to educators. As outlined within the Institute of Education Sciences report to Congress (2007), which detailed the effects of software product implementation in reading and mathematics K-12 classrooms, educators need to be mindful of potential barriers to technology implementation. "Teachers must prepare the product for student use, monitor and help students as they use the product, maintain the technology, and monitor student progress" (p. 36).

Based upon this study's findings, teachers who are looking to implement educational video games in K-12 classrooms need to follow structured implementation plans to ensure technology is properly integrated. Teachers need not be overly concerned about their personal levels of video game play ability, although helpful; they should have a general familiarity of the educational tool being implemented. Familiarity of tool used in conjunction with structured implement plans would additionally help to produce the desired educational outcome. Furthermore, educators should use vendor and school-specific implementation tools, when available, if electing to utilize an educational video game as a teaching tool or media (Kebritchi et al., 2008b).

Although it is a necessity for teachers to have understanding of technology integration in order to fulfill educational teaching standards, familiarity need only be superficial in terms of video game versioning as this study did not support the need for engendered game versioning or design. This study did however support the need for teachers to mitigate video game play activities during instruction. Therefore, structured implementation plans would provide sustainability of classroom video game integration by allowing the environment to perpetuate in a holistic manner under guidance of its facilitator. As Ertmer (2005) found, there is a high correlation between teachers who have positive beliefs in technology and in-class utilization; thus, based upon this study's findings, teachers who believe in the potential of educational video games and utilize structured implementation plans will positively influence learning outcomes.

Future research consideration may include cohort game development between those mentioned above to ensure the game meets not only national standards but also a teacher's goals in the classroom. Due to the nature of game development, this request may not be feasible. Though a game may be a positive mechanism in a K-12 setting, the redesign and development process associated with meeting desired educational modifications may often be too daunting.

Recommendations for Future Research

Below are suggestions for future research offered after having completed the present study. As seen in Figure 10 and Figure 12, females are more involved in computer utilization and game play than once believed. Therefore, these suggestions for further research may be helpful to those who wish to additionally investigate the further potential for educational video game utilization in K-12 classroom settings. Future research studies can be of further assistance in informing instructional and game designers as well as educators and administrators of the potential value of video game play in 21st century classrooms.

1. Use a game that contains customization or “modding” features.
2. Investigate reward type play of (a) in-game point rewards and (b) environmental conditions, such as game play as a reward for early completion of in-class assignments, for motivational trends.
3. Examine contextual settings for effects upon game play.
4. Further, explore Squire’s (2004) stated “transfer problem” analysis.
5. Follow a case study example examining a design cohort that includes students, teachers, and subject matter experts (SMEs) to follow the creation interaction, testing analysis, and production or release of the educational video game.
6. Track female tool repurposing of educational video games in comparison to everyday technology repurposing.
7. Create and test an implementation instrument or checklist.
8. Conduct an experimental design that includes an introductory game play seminar as the treatment.
9. Conduct surveys regarding the acceptance of female-only types of software, tools, and networks.
10. Investigate relationships between a teacher’s personal game usage and in-class implementation success and usage.

Just as people have different personalities, females may have different likes and dislikes with regard to particular games, however, that did not stop females from playing the video games as seen during observation in the present study. Both genders expressed similarities and disagreement concerning the game's content. Yet, no unified cause emerged to support an engendered design focus. Oddly, while students stated their beliefs that there are many shooting types of games, they did not refer to these games as violent. This may indicate that only adults, for the most part, view particular games as violent. Overall, the majority of the requests for change surrounded character and weapon customization. The parallel findings between genders were: (a) character creations, (b) more tools with which to work, (c) lag in game play, and (d) competition needs. To expand a game's functionality, a game needs to include customization options for the masses, but still hold true and fast to its original purpose, i.e., a game created to align to curriculum.

Teachers in all educational settings, K-12 and higher education, need to encourage programmers to develop games and tools that appeal to the masses rather than create additional barriers that do not conform to the current classroom demographics. Additionally, developers must be mindful that schools are strapped for both time and money. Schools cannot afford different versioning of the same game even if produced with female purpose in mind.

Teachers need to choose the innovations carefully when they implement in their classrooms. Educators are responsible for maintaining equal opportunities for all students (Entertainment Software Association (ESA), 2007). Therefore, teachers need to take on the task of demanding more from gaming and software companies. Game companies should survey both teachers and students while creating games to gather more content design understanding.

Based on this study and the literature reviewed, differences between the sexes appear only superficial. However, time and comfort factors appear to present some differences worthy of attention, as females approach game play with caution and need to understand the task before proceeding. Furthermore, time and rules of engagement for game play (when not outlined) become the female equivalent to a barrier; further consideration to the slightest barrier needs consideration during implementation.

When research designs and contexts in which educational video game effects have been examined, results have varied (Hyde et al., 1990a). Research regarding educational video games pertaining to instructional design outcomes must continue until overarching findings are in agreement.

Clark versus Kozma may always continue to be a topic for discussion. However, agnostic educators must take note that games provide the impetus for academic learning. It is, however, not in the endogenous nature of students to view video game play as learning since students do not immediately associate fun or entertainment as learning. Thus, when motivation for learning becomes a barrier, the lack of significance in motivation for a topic does not necessarily equate to a negative achievement outcome. With proper implementation of video game play activities, along with imbedded customization design features, students can be motivated. In doing so, designers will create an enjoyable learning environment for helping students excel in knowledge and understanding. The onus becomes learning to balance the use of an emergent technology with in-class pedagogy experiences to benefit both sexes.

APPENDIX A: VIDEO GAME MATHEMATICS STANDARDS CORRELATION

Mission 02 R & D

Learning Objectives and Correlations

Mission 02 Objectives and Correlations to FL Sunshine and National Standards

Objectives	FL Standards	NCTM Standards
2.1 Given a multiple, the students will find its prime factors. 2.2 Given two numbers, students will find their greatest common factor. 2.3 Given a pair of numbers, students will determine the least common multiple.	Strand A: Number Sense, Concepts, and Operations. Standard 5: The student understands and applies theories related to numbers. Benchmark MA.A.5.3.1: The student uses concepts about numbers, including primes, factors, and multiples, to build number sequences. ~~ Strand A: Number Sense, Concepts, and Operations. Standard 5: The student understands and applies theories related to numbers. Benchmark MA.A.5.3.1: The student uses concepts about numbers, including primes, factors, and multiples, to build number sequences. ~~ Strand A: Number Sense, Concepts, and Operations. Standard 5: The student understands and applies theories related to numbers. Benchmark MA.A.5.3.1: The student uses concepts about	Number and Operations Standard for Grades 6–8: Use factors, multiples, prime factorization, and relatively prime numbers to solve problems. Problem Solving Standards for Grades 6-8: Solve problems that arise in mathematics and in other contexts. ~~ Number and Operations Standard for Grades 6–8: Use factors, multiples, prime factorization, and relatively prime numbers to solve problems. Problem Solving Standards for Grades 6-8: Solve problems that arise in mathematics and in other contexts. ~~ Number and Operations Standard for Grades 6–8: Use factors, multiples, prime factorization, and relatively prime numbers to solve problems. Problem Solving Standards for Grades 6-8: Solve problems that arise in mathematics and in other contexts.

	numbers, including primes, factors, and multiples, to build number sequences.	

Mission 02 R & D

Learning Objectives and Correlations

Mission 02 Objectives and Correlations to FL Sunshine and National Standards

Objectives	FL Standards	NCTM Standards
2.1 Given a multiple, the students will find its prime factors. 2.2 Given two numbers, students will find their greatest common factor. 2.3 Given a pair of numbers, students will determine the least common multiple.	Strand A: Number Sense, Concepts, and Operations. Standard 5: The student understands and applies theories related to numbers. Benchmark MA.A.5.3.1: The student uses concepts about numbers, including primes, factors, and multiples, to build number sequences. ~~ Strand A: Number Sense, Concepts, and Operations. Standard 5: The student understands and applies theories related to numbers. Benchmark MA.A.5.3.1: The student uses concepts about numbers, including primes, factors, and multiples, to build number sequences. ~~ Strand A: Number Sense, Concepts, and Operations. Standard 5: The student understands and applies theories related to numbers. Benchmark MA.A.5.3.1: The student uses concepts about	Number and Operations Standard for Grades 6–8: Use factors, multiples, prime factorization, and relatively prime numbers to solve problems. Problem Solving Standards for Grades 6-8: Solve problems that arise in mathematics and in other contexts. ~~ Number and Operations Standard for Grades 6–8: Use factors, multiples, prime factorization, and relatively prime numbers to solve problems. Problem Solving Standards for Grades 6-8: Solve problems that arise in mathematics and in other contexts. ~~ Number and Operations Standard for Grades 6–8: Use factors, multiples, prime factorization, and relatively prime numbers to solve problems. Problem Solving Standards for Grades 6-8: Solve problems that arise in mathematics and in other contexts.

	numbers, including primes, factors, and multiples, to build number sequences.	

APPENDIX B: LITERATURE REVIEW ANALYSIS

	A	B	C	D	E	F
1	**2000 - 2008 Gaming Literature Review (ESBCO Host Searching Eric, PsLit, PsInfo, and Medline. Dissertation Abstracts)**					
2	*APA Reference*	*Classification*	*Game, if so Type*	*Gender*	*Statistical Measurement*	*Other*
3	Alvermann, D. E., Huddleston, A., & Hagood, M. C. (2004). What Could Professional Wrestling and School Literacy Practices Possibly Have in Common? Journal of Adolescent & Adult Literacy, 47(7), 532.	Discussion	Games General	No		Wrestling and literarcy
4	Annetta, L., Murray, M., Gull Laird, S., Bohr, S., & Park, J. (2008). Investigating Student Attitudes toward a Synchronous, Online Graduate Course in a Multi-User Virtual Learning Environment. Journal of Technology and Teacher Education, 16(1), 5.	Research	Video Games	Yes	ANCOVA	Attitudes towards VLE (virt learn environ)'s case study; no gender diff math; computer games chasm between physical sciences & technology; males positive attitude, more video games, showed more confidence; no diff b/w learning for gender; 5th grade teacher-dev MEGA for sci
5	Bailey, K. (2002). Hooked on Hummingbirds. Green Teacher(67), 20.	Development	Educational Games	No		Hummingbird behavior
6	Bernier, R. (2003). Usability of Interactive Computers in Exhibitions: Designing Knowledgeable Information for Visitors. Journal of Educational Computing Research, 28(3), 245.	Research	Games General	No		Testing Exhibits in Museum of Civilization
7	Bickham, D. S., Vandewater, E. A., Huston, A. C., Lee, J. H., Caplovitz, A. G., & Wright, J. C. (2003). Predictors of children's electronic media use: An examination of three ethnic groups. Media Psychology, 5(2), 107-137.	Research	Video Games	No		Media Use; Referred to aas Electronic Video Games and studied ethnicity
8	Blumberg, F. C., & Sokol, L. M. (2004). Boys' and girls' use of cognitive strategy when learning to play video games. The Journal Of General Psychology, 131(2), 151-158.	Research	Video Games	Yes	ANOVA (Z Scores)	Learning to Play Video Games
9	Blumberg, F. C., Rosenthal, S. F., & Randall, J. D. (2008). Impasse-driven learning in the context of video games. Computers in Human Behavior, 24(4), 1530-1541.	Research	Video Games	No		Game strategies
10	Bonanno, P., & Kommers, P. A. M. (2008). Exploring the influence of gender and gaming competence on attitudes towards using instructional games. British Journal of Educational Technology, 39(1), 97-109.	Research	Digital Games	Yes	Qual Survey	Social networking, college students, gaming influences; attitude for gaming; males more confident w/hardware; both sexes believed in gaming; females lacked confidence
11	Bragg, L. (2007). Students' Conflicting Attitudes towards Games as a Vehicle for Learning Mathematics: A Methodological Dilemma. Mathematics Education Research Journal, 19(1), 29.	Research	Games General	No		Calculator Games; Negative Attitudes of Games; 5th & 6th grade

	A	B	C	D	E	F
12	Cartwright, E. (2007). Imitation, coordination and the emergence of Nash equilibrium. International Journal of Game Theory, 36(1), 119-135.	Theory	Games General	No		Nash equilibrium play to emerge; imitation of play
13	Cassity, H. D., Henley, T. B., & Markley, R. P. (2007). The Mozart Effect: Musical Phenomenon or Musical Preference? A More Ecologically Valid Reconsideration. Journal of Instructional Psychology, 34(1), 13.	Research	Other	No		Mozart Music increase Spatial
14	Clark, S., & Smith, G. B. (2004). Outbreak!: Teaching Clinical and Diagnostic Microbiology Methodologies with an Interactive Online Game. Journal of College Science Teaching, 34(1), 30.	Review	Educational Games	No		Outbreak a review
15	Clark-Ridgway, A. J. (2000). Foreign Language Students' Perceptions of Instructional Techniques That Promote Language Learning.	Research	Other	No		Foreign Language
16	Costello, B., & Kolodziej, N. J. (2006). A Middle School Teacher's Guide for Selecting Picture Books. Middle School Journal (J1), 38(1), 27.	Discussion	Other	No		Picture books
17	Damis-Paraboschi, F., Lafont, L., & Menaut, A. (2005). A Social-Constructivist Approach in Physical Education: Influence of Dyadic Interactions on Tactical Choices in an Instructional Team Sport Setting. European Journal of Psychology of Education, 20(2), 171.	Research	Games General	Yes	RMANOVA	Verbal in Game Play (handball); dyadic verbal peer interactions; males performed better in action efficency
18	De Lisi, R., & Wolford, J. L. (2002). Improving children's mental rotation accuracy with computer game playing. The Journal Of Genetic Psychology, 163(3), 272-282.	Research	computer games	Yes	ANOVA	Games increase spatial abilties; Mental Rotation (MR) skills study
19	Dickey, M. (2006). Game Design Narrative for Learning: Appropriating Adventure Game Design Narrative Devices and Techniques for the Design of Interactive Learning Environments. Educational Technology Research & Development, 54(3), 245-263.	Discussion	Video Games	No	Analysis	Voice and narrative for classroom game design
20	Dickey, M. (2007). Game design and learning: a conjectural analysis of how massively multiple online role-playing games (MMORPGs) foster intrinsic motivation. Educational Technology Research & Development, 55(3), 253-273.	Discussion	MUVE	No	Analysis	MMORPG popularity
21	Dickey, M. D. (2005). Engaging By Design: How Engagement Strategies in Popular Computer and Video Games Can Inform Instructional Design. Educational Technology Research and Development, 53(2), 67.	Discussion	Video Games	No		Game Design

	A	B	C	D	E	F
22	DiPietro, M., Ferdig, R. E., Boyer, J., & Black, E. W. (2007). Towards a Framework for Understanding Electronic Educational Gaming. Journal of Educational Multimedia and Hypermedia, 16(3), 225.	Theory	Educational Games	Yes	Discussion	Diffusion; Games and gaming have always been an influential part of society and culture. Within the last 35 years, due to numerous technology innovations, electronic games in many formats have become ubiquitous in everyday life; findings indicate three overarching themes for learning w/games: locus of control, self-efficacy, & valence
23	Eglesz, D., Fekete, I., Kiss, O. E., & Izso, L. (2005). Computer games are fun? On professional games and players' motivations. Educational Media International, 42(2), 117-124.	Research	Video Games	Yes	Kruskal-Wallis test	What motivates people to sit al day and play; 10 - 14 yo.s 1000 students.
24	Feng, J. (2006). Cognitive training using action video games: A new approach to close the gender gap. Unpublished M.A., University of Toronto (Canada), Canada.	Research	Video Games	Yes	RMANOVA	Use of View Field (UFOV); gender differences show UFOV is reduced by using video games
25	Fengfeng, K., & Grabowski, B. (2007). Gameplaying for maths learning: cooperative or not? British Journal of Educational Technology, 38(2), 249-259.	Research	Games General	Yes	MANCOVA	Teams-Games-Tournament (TGT); using a standards based math test (pre/post)
26	Fraser, H. P., Kemp, S., & Keenan, T. (2007). How do children behave when they distribute rewards from task participation? European Journal of Developmental Psychology, 4(2), 198-219.	Research	Games General	No		Distributional Justice when playing games; 5, 7 and 9 yo
27	Gambler, E. D. (2004). Improving student achievement in AP statistics through the use of contextualized extended response questions with settings of interest to students. Unpublished Ed.D., Temple University, United States -- Pennsylvania.	Research	Other	Yes	ANOVA	Studied student interests. Contextualized extended response questions to determine student achievement improvement (trying to improve achievement based on stated findings) Female interests
28	Garris, R., Ahlers, R., & Driskell, J. E. (2002). Games, motivation, and learning: A research and practice model. Simulation & Gaming, 33(4), 441-467.	Theory	Educational Games	No		Context features to create; characteristics of instructional games. Motivational support
29	Gentile, D. A., & Gentile, J. R. (2008). Violent Video Games as Exemplary Teachers: A Conceptual Analysis. Journal of Youth and Adolescence, 37(2), 127.	Research	Video Games	No		Violent Games
30	Ginat, D. (2006). Winning Moves and Illuminating Mathematical Patterns. Mathematics and Computer Education, 40(1), 42.	Discussion	Games General	No		Math patterns and math games

	A	B	C	D	E	F
31	Goodman, D., Bradley, N. L., Paras, B., Williamson, I. J., & Bizzochi, J. (2006). Video gaming promotes concussion knowledge acquisition in youth hockey players. Journal Of Adolescence, 29(3), 351-360.	Research	Video Games	No		Video w/embedded educational aspects in design. Hockey study; Video Positive
32	Hamalainen, R. (2008). Designing and Evaluating Collaboration in a Virtual Game Environment for Vocational Learning. Computers & Education, 50(1), 98.	Research	Games General	No		Callaborative And Cooperative Learning
33	Hayes, E. (2005). Women, Video Gaming and Learning: Beyond Stereotypes. TechTrends: Linking Research & Practice to Improve Learning, 49(5), 23.	Discussion	Video Games	Yes	Discussion	Gender Stereotypes
34	Hayes, E. (2005). Women, Video Gaming and Learning: Beyond Stereotypes. TechTrends: Linking Research & Practice to Improve Learning, 49(5), 23.	Discussion	Video Games	Yes	Discussion	Design implications; "casual types of games for women such as tetris and solitaire or SIMS
35	Herrera, T. A. (2004). Number Time. Teaching Children Mathematics, 10(9).	Discussion	Other	No		BBC site discussion; animation
36	Hoyles, C., Noss, R., & Adamson, R. (2002). Rethinking the microworld idea. Journal of Educational Computing Research, 27(1), 29-53.	Discussion	Video Games	Yes	Case Study	Case study 2 - 8 yo girls rebuilding simple video game
37	Hsi, S. (2007). Conceptualizing Learning from the Everyday Activities of Digital Kids. International Journal of Science Education, 29(12), 1509.	Discussion	Video Games	No		Digital Fluency; Collaborative Seeting; naturalistic setting
38	Hutchison, D. (2007). Video Games and the Pedagogy of Place. Social Studies, 98(1), 35.	Discussion	Video Games	No		Construction of place within virtual worlds; Use strategies in game and pedagody
39	Inal, Y., & Cagiltay, K. (2007). Flow Experiences of Children in an Interactive Social Game Environment. British Journal of Educational Technology, 38(3), 455.	Research	computer games	Yes	Mean Analysis; Qual	Flow theory; 33 children ages 7 - 9; flow occurred more among boys than girls
40	Jones, G., & Kalinowski, K. (2007). Touring Mars Online, Real-time, in 3D for Math and Science Educators and Students. Journal of Computers in Mathematics and Science Teaching, 26(2), 123.	Research	MUVE	No		3D MUVE Environ MARS
41	Jones, M. J. (2004). The Effect of Participation in the Neighborhood Academic Program on the Autophotographic Self-Concepts of Inner-City Adolescents. Journal of Instructional Psychology, 31(3), 188.	Research	Other	No	Qual Survey; Qual Analysis	Neighborhood Academic Initiative (NAI) Scholars Programse Self-Concept; Involved African-Americans and Hispanics
42	Jones, R. (2005). What Do Children Most Enjoy about Summer Soccer Camp? Gender and Group Perceptions. Physical Educator, 62(1), 2.	Research	Games General	Yes	Qual/Questionnarire	Summer Camp Social Experiences

	A	B	C	D	E	F
43	Judd, W. (2007). Instructional Games with Calculators. Mathematics Teaching in the Middle School, 12(6), 312.	Review	Other	No		Calculator Games
44	Kafai, Y. B. (2006). Playing and Making Games for Learning: Instructionist and Constructionist Perspectives for Game Studies. Games and Culture: A Journal of Interactive Media, 1(1), 36-40.	Discussion	Educational Games	No		Making vs. playing games; Instructionist vs. Constructionist
45	Kirk, J. J. (2001). An Unofficial Guide to Web-Based Instructional Gaming and Simulation Resources.	Review	Educational Games	No		Teaching Games for Understanding (TAGU) model situated learning perspective.100 Games to Use
46	Kirkley, S. (2005). Emerging Technologies and Learning Environment Design. TechTrends: Linking Research & Practice to Improve Learning, 49(3), 2-3.	Discussion	Video Games	No		Design Principles (vid games and simulations)
47	Kontos, G., & Mizell, A. P. (2005). The Global Quiz Bowl: Competing and Cooperating through Compressed Video. TechTrends: Linking Research & Practice to Improve Learning, 49, 16.	Research	Games General	No		Quiz Bowl
48	Labour, M., Leleu-Merviel, S., & Vieville, N. (2004). Using a Quality-Led Multimedia Approach for Interpersonal Communication Training. Journal of Educational Multimedia and Hypermedia, 13(2), 185.	Discussion	Educational Games	No		Situated Learning; Interactive Media; Scenistic & SNOW design approaches
49	Littin, R. M. (2001). Relationship(s) between and among an urban elementary school's grades three through five students' learning styles, cognitive styles, reading achievement, hemispheric preference, and gender. Unpublished Ed.D., St. John's University (New York), School of Education and Human Services, United States -- New York.	Research	Other	Yes	ANOVA	(Dissertation) Cognitive and learning styles, as well as hemispheric preferences, grade, and gender were examined to determine their impact on reading achievement; purpose was to determine how learning style, cognitive style, cognitive processing, and hemispheric preferences related to each other. DGENDER DIFF ID.2; 3rd grade

	A	B	C	D	E	F
50	Margolis, J. L., Nussbaum, M., Rodriguez, P., & Rosas, R. (2006). Methodology for evaluating a novel education technology: a case study of handheld video games in Chile. Computers & Education, 46(2), 174-191.	Theory	Educational Games	No		Method for evaluating educational technology for inclusion; benefit analysis, through the administration cost analysis, which incorporates costs to weigh against the benefits; and feasibility analysis, which introduces real-world concerns that may affect the ability to actually implement the technology.
51	Markey, C., Power, D., & Booker, G. (2003). Using Structured Games to Teach Early Fraction Concepts to Students Who Are Deaf or Hard of Hearing. American Annals of the Deaf, 148(3), 251.	Research	Games General	No		Hearing-Impaired; Using Games
52	Mayer, R. E., & Moreno, R. (2002). Animation as an aid to multimedia learning. Educational Psychology Review, 14(1), 87-99.	Discussion	Other	No		Multimedia Animation
53	Nippold, M. A., Duthie, J. K., & Larsen, J. (2005). Literacy as a leisure activity: free-time preferences of older children and young adolescents. Language, Speech, And Hearing Services In Schools, 36(2), 93-102.	Research	Other	No		Literacy; Activities survey
54	Peterson, M. R., Balzarini, D., Bodner, M., Jones, E. G., Phillips, T., Richardson, D., et al. (2004). Innate spatial-temporal reasoning and the identification of genius. Neurological Research, 26(1), 2-8.	Review	Video Games	No		Big Speeed a reivew; spatial-temp (ST)
55	Pijls, M., Dekker, R., & van Hout-Wolters, B. (2003). Mathematical Level Raising through Collaborative Investigations with the Computer. International Journal of Computers for Mathematical Learning, 8(2), 191.	Research	Other	No		difference in level raising between three versions of the learning materials: investigations with the computer "before", "during" or "after" the learning of a mathematical concept;Games before and after; no def games

	A	B	C	D	E	F
56	Pinder, P. J. (2008). Utilizing Instructional Games to Improve Students' Conceptualization of Science Concepts: Comparing K Students Results with Grade 1 Students, Are There Differences? : Online Submission.	Research	Educational Games	No	Mean Scores; Test unstated; Mixed-anlaysis	K-1 only; motivational similiar to world experiences; motivational levels to do academic work; Game Activity Intervention; game activity intervention conducted, reports on prior intervention results obtained a year ago, and also gives practitioners' views and perspectives on the effectiveness of instructional games for pre K and K-5 students
57	Rayya, M. A., & Hamdi, N. (2001). The impact of using educational games strategy conducted by computer assisted instruction in acquiring the four mathematical skills for sixth grade students. Dirasat: Educational Sciences, 28(1), 164-176.	Research	Educational Games	Yes	Pre/Post	Math; 6th graders 4 math concepts; no differences;
58	Reese, D. D. (2007). First Steps and beyond: Serious Games as Preparation for Future Learning. Journal of Educational Multimedia and Hypermedia, 16(3), 283.	Discussion	Games General	No	Discussion	Game Design Theory; flow; prior knowledge not needed
59	Rice, J. (2007). Assessing Higher Order Thinking in Video Games. Journal of Technology and Teacher Education, 15(1), 87.	Discussion	Video Games	No	Discussion; Qual	Barriers to game Play in Classroom; Time; Lack of Standards; perception of education
60	Richmond, T. K., Field, A. E., & Rich, M. (2007). Can neighborhoods explain racial/ethnic differences in adolescent inactivity? International Journal Of Pediatric Obesity: IJPO: An Official Journal Of The International Association For The Study Of Obesity, 2(4), 202-210.	Research	Games General	Yes	cross-sectional analysis	Neighborhoods/Ethicity; explain racial/ethnic disparities in adolescent physical inactivity
61	Rosas, R., Nussbaum, M., Cumsille, P., Marianov, V., Correa, M. n., Flores, P., et al. (2003). Beyond Nintendo: design and assessment of educational video games for first and second grade students. Computers & Education, 40(1), 71.	Research	Educational Games	No	(Not Found)	study was to evaluate the effects of the introduction of educational videogames into the classroom, on learning, motivation, and classroom dynamics. These effects were studied using a sample of 1274 students from economically disadvantaged schools; no prior knowledge needed; motivation 7 lerning context "motivations iport to learning" optimalr eperinece great job QUote!!!

	A	B	C	D	E	F
62	Sedig, K. (2008). From Play to Thoughtful Learning: A Design Strategy to Engage Children with Mathematical Representations. Journal of Computers in Mathematics and Science Teaching, 27(1), 65.	Research	Games General	No	Quasi-Exp; pre to post (t-test)	QUOTE: design of game slowly shifts attention!!!!! Children don't like math; effectivness of games; FLOW, a type of intrinsic motivation, has been described as an optimal experience in which a learner can derive great joy from a learning activity. Super Tangrams
63	Sensevy, G., Schubauer-Leoni, M.-L., Mercier, A., Ligozat, F., & Perrot, G. (2005). An Attempt to Model the Teacher's Action in the Mathematics Class. Educational Studies in Mathematics, 59, 153.	Theory	Educational Games	No		Model to sstudy math teacher actions
64	Shaffer, D. W. (2006). Epistemic frames for epistemic games. Computers & Education, 46(3), 223-234.	Theory	Other	No		Epistemic frames proposed computer-supported; speaks to Video Games, computer Games, and other interactive learning environments
65	Tallir, I. B., Lenoir, M., Valcke, M., & Musch, E. (2007). Do alternative instructional approaches result in different game performance learning outcomes? Authentic assessment in varying game conditions. International Journal of Sport Psychology, 38(3), 263-282.	Research	Games General	Yes	RM	Bball training vs Game Approach
66	Tobias, S., & Fletcher, J. D. (2007). What Research Has to Say about Designing Computer Games for Learning. Educational Technology Magazine: The Magazine for Managers of Change in Education, 47(5), 20.	Review	Educational Games	No		Game Designers improve pedagogy effects; differences between instructional games and instructional simulations
67	VanEck, R. (2006). Digital game-based learning. Educause Review, 41(2), 16-18.	Research	Video Games	No		Video Games definitions; discussion regard to learning; dgbl; Integration assignment w/ curriculum, "existing ed. cannot support DGBL!!!"
68	Villano, M. (2008). When Worlds Collide: An Augmented Reality Check. T.H.E. Journal, 35(2), 33.	Development	Simulations	No		Mobile GPS, Digi Sim
69	Vogel, J. J., Greenwood-Ericksen, A., Cannon-Bowers, J., & Bowers, C. A. (2006). Using Virtual Reality with and without Gaming Attributes for Academic Achievement. Journal of Research on Technology in Education, 39(1), 105.	Research	Other	No	One-Tailed P-Test; Quasi Pre/Post Design; no def games; K-6	Computer-Assisted Instruction (CAI) gamesSimulation should be implemented into game teaching;

	A	B	C	D	E	F
70	Winebrenner, S. (2001). Teaching Gifted Kids in the Regular Classroom: Strategies and Techniques Every Teacher Can Use To Meet the Academic Needs of the Gifted and Talented. Revised, Expanded, Updated Edition.	Discussion	Other	No		Gifted kids planning; Book about classroom practices
71	Zaborskis, A., Zemaitiene, N., Borup, I., Kuntsche, E., & Moreno, C. (2007). Family joint activities in a cross-national perspective. BMC Public Health, 7(147), 94-94.	Research	Games General	Yes	Cross-National Survey	Activities with parents and children survye

APPENDIX C: MOTIVATION SURVEY

Course Motivation Survey
(CMS)

Atsusi Hirumi, Ph.D.
Associate Professor and Co-Chair
Instructional Technology
University of Central Florida
Orlando, FL 32816
hirumi@mail.ucf.edu

Course Motivation Survey (CMS)

Instructions

1. There are 20 statements in this questionnaire. Please think about each statement in relation to the Mathematics class that you are about to participate in and indicate how true the statements are using the scale provided after each statement. Give the answer that truly applies to you and not what you would like to be true, or what you think others want to hear.

2. Think about each statement by itself and indicate how true it is. Do not be influenced by your answers to other statements.

3. Circle the number that best indicates your response, and follow any additional instructions that may be provided in regard to the answer sheet that is being used with this survey. Be sure to circle a number. DO NOT circle any space between the numbers.

Scale for Your Responses
1 (or A) =Not true
2 (or B) =Slightly true
3 (or C) =Moderately true
4 (or D) =Mostly true
5 (or E) =Very true

Course Motivation Survey (CMS)

Name: ____________________________ Teacher: __________________________ Class: ________________

Please remember to circle a number. DO NOT circle any space between numbers.

1. I think this Mathematics class will be challenging, but neither too easy, nor too hard for me.

1-------------------2-------------------3-------------------4-------------------5
Not true Slightly true Moderately true Mostly true Very true

2. There is something interesting about this Mathematics class that will capture my attention.

1-------------------2-------------------3-------------------4-------------------5
Not true Slightly true Moderately true Mostly true Very true

3. This Mathematics class seems more difficult than I would like for it to be.

1-------------------2-------------------3-------------------4-------------------5
Not true Slightly true Moderately true Mostly true Very true

4. I believe that completing this Mathematics class will give me a feeling of satisfaction.

1-------------------2-------------------3-------------------4-------------------5
Not true Slightly true Moderately true Mostly true Very true

5. It is clear to me how this Mathematics class is related to things I already know.

1-------------------2-------------------3-------------------4-------------------5
Not true Slightly true Moderately true Mostly true Very true

6. I believe this Mathematics class will gain and sustain my interest.

1-------------------2-------------------3-------------------4-------------------5
Not true Slightly true Moderately true Mostly true Very true

7. I believe that the information contained in this Mathematics class will be important to me.

1-------------------2-------------------3-------------------4-------------------5
Not true Slightly true Moderately true Mostly true Very true

8. As I learn more about this Mathematics class, I am confident that I could learn the content.

1-------------------2-------------------3-------------------4-------------------5
Not true Slightly true Moderately true Mostly true Very true

9. I believe that I will enjoy this Mathematics class so much that I would like to know more about this topic.

1-------------------2-------------------3-------------------4-------------------5
Not true Slightly true Moderately true Mostly true Very true

10. The Mathematics class seems dry and unappealing.

1--------------------2--------------------3--------------------4--------------------5
Not true Slightly true Moderately true Mostly true Very true

11. The Mathematics class is relevant to my interests.

1--------------------2--------------------3--------------------4--------------------5
Not true Slightly true Moderately true Mostly true Very true

12. It is apparent to me how people use the information in this Mathematics class.

1--------------------2--------------------3--------------------4--------------------5
Not true Slightly true Moderately true Mostly true Very true

13. I will really enjoy completing assignments for this Mathematics class.

1--------------------2--------------------3--------------------4--------------------5
Not true Slightly true Moderately true Mostly true Very true

14. After working on this Mathematics class for awhile, I believe that I will be confident in my ability to successfully complete all class assignments and requirements.

1--------------------2--------------------3--------------------4--------------------5
Not true Slightly true Moderately true Mostly true Very true

15. I think that the variety of materials, exercises, illustration, etc., will help keep my attention on this Mathematics class.

1--------------------2--------------------3--------------------4--------------------5
Not true Slightly true Moderately true Mostly true Very true

16. The technology that will be used to deliver this Mathematics class may be frustrating/irritating.

1--------------------2--------------------3--------------------4--------------------5
Not true Slightly true Moderately true Mostly true Very true

17. It will feel good to successfully complete this Mathematics class.

1--------------------2--------------------3--------------------4--------------------5
Not true Slightly true Moderately true Mostly true Very true

18. The contents of this Mathematics class does not include information that will useful to me.

1--------------------2--------------------3--------------------4--------------------5
Not true Slightly true Moderately true Mostly true Very true

19. I do NOT think that I will be able to really understand the information in this Mathematics class.

1--------------------2--------------------3--------------------4--------------------5
Not true Slightly true Moderately true Mostly true Very true

20. I do not think that this course will be worth my time and effort.

1--------------------2--------------------3--------------------4--------------------5
Not true Slightly true Moderately true Mostly true Very true

Overview of the ARCS Model

Summary of the ARCS Model

The ARCS model, developed by Keller (Keller, 1987a; Keller, 1987b), provides a systematic process for analyzing student motivation and designing motivationally effective instruction. It also helps to organize knowledge of human motivation. He argues that the plethora of constructs related to human motivation makes it difficult for practitioners to transfer theory into practice. To develop a comprehensive measure of learners' motivation, educators would have to apply a battery of tests which is not practical in most instructional situations. By synthesizing the various theories of human motivation, Keller has constructed a model, with related instruments that allow researchers and practitioners to form a comprehensive profile of learners' situational motivation.

Keller posits that theories of human motivation may be subsumed under four general categories: A--Attention, R--Relevance, C-Confidence, and S--Satisfaction. In order to motive students to learn, instruction must: (1) gain and sustain learners attention; (2) be relevant to their needs; (3) promote learners confidence in their ability to succeed; and (4) satisfy learners (e.g., results were worth time and effort). There are a number of concepts related to each major category. The following is a list of concepts related to each category, along with corresponding theories of human motivation.

Attention - To motivate students to learn, instruction must gain and sustain attention.

A1. Perceptual Arousal - Stimulate senses
A2. Inquiry Arousal - Stimulate curiosity
A3. Variability - Vary stimulus

Theoretical Foundations
- Curiosity (Maw & Maw, 1968)
- Perceptual Arousal (Berlyne, 1965)
- Inquiry Arousal (Kaplan, 1964)

Relevance - To motivate students to learn, instruction must be relevant to their needs.

R1. Goal Orientation - Help students create and achieve goals
R2. Motive Matching - Address specific needs
R3. Familiarity - Relate to learners' past experiences

Theoretical Foundations
- Drive Theories (Hull, 1943)
- Needs Hierarchy (Maslow, 1954; Murray, 1938)
- Need for Achievement (McClelland, Atkinson, Clark & Lowell, 1953)

Confidence - To motivate students to learn, they must have confidence in their ability to succeed.

C1. Learning Requirements - Awareness of expectations and evaluation criteria.
C2. Success Opportunities - Opportunities to experience success.
C3 Personal Control - Link success or failure to student effort and abilities.

Theoretical Foundations
- Self-efficacy (Bandura, 1977)
- Locus of Control (Rotter, 1954)
- Learned Helplessness (Seligman, 1975)

Satisfaction - To motivate students to learn, learners must be satisfied that the results of instruction were worth their time and effort.

S1. Natural Consequences - Meaningful opportunities to apply learned skills?
S2. Positive Consequences - Positive reinforcement
S3. Equity - Consequences perceived to be fair by all students

Theoretical Foundations
- Conditioning Theory (Travers, 1977)
- Cognitive Evaluation Theory (Deci, 1975)

Purpose of the CMS

The Course Motivation Survey is intended to be a situational measure of students' perceived levels of motivation toward a course. It is based on Keller's' Instructional Materials Motivation Survey (IMMS) that assess learners' motivation reaction to specific instructional materials.

The CMS and IMMS are designed in accordance with the theoretical foundation represented by the ARCS Model (Keller, 1987a; Keller, 1987b). This theory is derived from the current literature on human motivation, hence, many of the items in the CMS are similar in intent (but not in wording) to items established measures of psychological constructs such as need for achievement, locus of control, and self-efficacy, to mention three examples.

Reliability

Reliability estimates based on Cronbach's alpha measure were obtained for each subscale and the total scale for a version of CMS that contained 36 items. Reliability estimates were:

Attention	.89	Confidence	.90	Total Scale	.96
Relevance	.91	Satisfaction	.92		

In a validation study, differences in two sets of instructional materials with respect to format, content, and other features affection motivation were reflected in the differences in scores on the CMS.

CMS Scoring Guide

The response scale ranges from 1 to 5. This means that the minimum score on the 20 item survey is 20, and the maximum score is 100 with a midpoint of 60. The minimums, maximums, and midpoints for each subscale are comparable because they have the same number of items.

An alternative scoring method is to find the average score for each subscale and the total scale instead of using sums. For each respondent, divide the total score on a given scale by 5 (the number of items in that scale). This converts the totals into a score ranging from 1 to 5 and makes it easier to compare performance on each of the subscales.

There are no norms for the survey. As it is a situation specific measure, there is no expectation of a normal distribution of responses. As data becomes available from a variety of applications of the scales, descriptive statistical information will be published.

Scores are determined by summing the responses for each subscale and the total score. Please note that the items marked *reverse* are stated in a negative manner. The responses have to be reversed before they can be added into the response total. That is for these items, 5=1, 4=2, 3=3, 2=4, and 1=5.

Attention items

2	10 (reverse)	36 (reverse)
6	15	

Relevance items

5	11	18 (reverse)
7	12	

Confidence items

1	8	19 (reverse)
3 (reverse)	14	

Satisfaction items

4	13	20 (reverse)
9	17	

APPENDIX D: IRB CONSENT

University of Central Florida

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901, 407-882-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Notice of Expedited Initial Review and Approval

From : **UCF Institutional Review Board**
FWA00000351, Exp. 5/07/10, IRB00001138

To : **Atsusi Hirumi**

Date : **August 01, 2007**

IRB Number: **SBE-07-05091**

Study Title: **The Effects of Modern Math Computer Games on Student Math Achievement, Math Anxiety and Motivation.**

Dear Researcher:

Your research protocol noted above was approved by **expedited** review by the UCF IRB Chair on 7/30/2007. **The expiration date is 7/29/2008.** Your study was determined to be minimal risk for human subjects and expeditable per federal regulations, 45 CFR 46.110. The category for which this study qualifies as expeditable research is as follows:

7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

The IRB has approved a **consent procedure which requires participants to sign consent forms.** Use of the approved, stamped consent document(s) is required. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Subjects or their representatives must receive a copy of the consent form(s).

All data, which may include signed consent form documents, must be retained in a locked file cabinet for a minimum of three years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained on a password-protected computer if electronic information is used. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

To continue this research beyond the expiration date, a Continuing Review Form must be submitted 2 – 4 weeks prior to the expiration date. Advise the IRB if you receive a subpoena for the release of this information, or if a breach of confidentiality occurs. Also report any unanticipated problems or serious adverse events (within 5 working days). Do not make changes to the protocol methodology or consent form before obtaining IRB approval. Changes can be submitted for IRB review using the Addendum/Modification Request Form. An Addendum/Modification Request Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at http://iris.research.ucf.edu .

Failure to provide a continuing review report could lead to study suspension, a loss of funding and/or publication possibilities, or reporting of noncompliance to sponsors or funding agencies. The IRB maintains the authority under 45 CFR 46.110(e) to observe or have a third party observe the consent process and the research.

On behalf of Tracy Dietz, Ph.D., UCF IRB Chair, this letter is signed by:

Signature applied by Janice Turchin on 08/01/2007 10:56:26 AM EDT

Janice M. Turchin

IRB Coordinator

APPENDIX E: CLASSROOM OBSERVATIONAL PROTOCOL

Use of Modern Educational Video Game
Classroom Observation Protocol[1]

BACKGROUND INFORMATION

Study: Experimental | Quasi Experimental
Date of Observation: ____________________
Time of Observation: Start __________ End ___________
Grade Level: ____________
Teacher Observed: ________________
Class Observed: __________________
Observer: ______________________________

SECTION ONE: CONTEXTUAL BACKGROUND AND ACTIVITIES

In this section, please fill in the circles that best describe the class. ***For each item, be sure to fill in all responses that apply.***

I. Classroom Demographics and Context

A. What is the total number of students in class at the time of the observation?
 15 or fewer
 16–20
 21–25
 26–30
 31 or more

B. What is the approximate percentage of the white (not Hispanic origin) students in this class?
 0–10 percent
 11–25 percent
 26–50 percent
 51–75 percent
 76–100 percent

C. Indicate the *teacher's*:
1. Gender
 Male Female

2. Race/Ethnicity
 African-American (not Hispanic origin)
 American Indian or Alaskan Native
 Asian or Pacific Islander
 Hispanic
 White (not Hispanic origin)
 Other

D. If applicable, indicate the *teacher aide's*:
1. Gender
 Male Female

2. Race/Ethnicity
 African-American (not Hispanic origin)
 American Indian or Alaskan Native
 Asian or Pacific Islander
 Hispanic
 White (not Hispanic origin)
 Other

[1] Modified protocol based on Horizon's Inc. Classroom Observation Protocol v2

E. Rate the adequacy of the physical environment.

1. Classroom resources:

O	O	O	O	O	
1	2	3	4	5	
Sparsely equipped					Rich in resources

2. Classroom Space:

O	O	O	O	O
1	2	3	4	5
Crowded				Adequate space

3. Room arrangement:

O	O	O	O	O	
1	2	3	4	5	
Inhibited interactions among students					Facilitated interactions among students

II. Lesson Description

In a paragraph or two, describe the lesson you observed. Include where this lesson fits in the overall unit of study. Be sure to include enough detail to provide a context for your ratings of this lesson and also

III. Purposes of Lesson[2]

A. Indicate the *major*[3] *content area(s)* of this lesson or activity.

□ 1. Numeration and number theory
□ 2. Computation (please specify: _______________)
□ 3. Estimation
□ 4. Measurement (please specify: _______________)
□ 5. Patterns and relationships
□ 6. Pre-algebra
□ 7. Algebra
□ 8. Geometry and spatial sense
□ 9. Probability
□ 10. Statistics (e.g., hypothesis tests,
□ 11. Topics from discrete mathematics (e.g., combinatorics, graph theory, recursion)
□ 12. Mathematicalstructures (e.g., vector spaces, groups, rings, fields)

[2] List of content areas modified from original protocol for the purposes of this study.
[3] "Major" means was used or addressed for a substantial portion of the lesson; if you were describing the lesson to someone, this feature would help characterize it.

□ 13. None of the above (please explain ________________)

B. Indicate the *primary intended purpose(s)* of this lesson or activity based on the pre- and/or post observation interviews with the teacher.
□ 1. Identifying prior student knowledge
□ 2. Introducing new concepts
□ 3. Developing conceptual understanding
□ 4. Reviewing mathematics/science concepts
□ 5. Developing problem-solving skills
□ 6. Learning mathematics/science processes, algorithms, or procedures
□ 7. Learning vocabulary/specific facts
□ 8. Practicing computation for mastery
□ 9. Developing appreciation for core ideas in mathematics/science
□ 10. Developing students' awareness of contributions of scientists/mathematicsians of diverse backgrounds
□ 11. Assessing student understanding

IV. Instructional Materials

A. Is this lesson based on instructional materials designated for use by Tabula Digita (TD)?
□ Yes □ No, SKIP to Part V below

B. Indicate the *single* set of TD-designated instructional materials intended to form the basis of this lesson
Please specify mission and game(s). ____

C. How closely did the lesson adhere to the instructions provided in the TD lesson plan?
□ Exactly, SKIP to Part V below
□ Almost totally □ Mostly □ Somewhat □ A little □ Hardly at all

D. How did the modifications affect the quality of the lesson design?
□ Helped a lot □ Helped a little □ Neutral □ Hurt a little □ Hurt a lot

V. Classroom Instruction

A. Indicate the *major*[4] *way(s)* in which student activities were structured.
□ As a whole group □ As small groups □ As pairs □ As individuals

B. Indicate the *major*[4] *way(s)* in which students engaged in class activities.
□ Entire class was engaged in the same activities at the same time.
□ Groups of students were engaged in different activities at the same time (e.g., centers).

4 "Major" means was used or addressed for a substantial portion of the lesson; if you were describing the lesson to someone, this feature would help characterize it.

C. Indicate the *major*[5] *activities* of students in this lesson. When choosing an "umbrella" category, be sure to indicate subcategories that apply as well. (For example, if you mark "listened to a presentation," indicate by whom.)

☐ 1. Listened to a presentation:
☐ a. By teacher (would include: demonstrations, lectures, media presentations, extensive procedural instructions)
☐ b. By student (would include informal, as well as formal, presentations of their work)
☐ c. By guest speaker/"expert" serving as a resource

☐ 2. Engaged in discussion/seminar:
☐ a. Whole group
☐ b. Small groups/pairs

☐ 3. Engaged in problem solving/investigation:
☐ a. Worked with manipulatives
☐ b. Played a game to build or review knowledge/skills
☐ c. Followed specific instructions in an investigation
☐ d. Had some latitude in designing an investigation
☐ e. Recorded, represented and/or analyzed data
☐ f. Recognized patterns, cycles or trends
☐ g. Evaluated the validity of arguments or claims
☐ h. Provided an informal justification or formal proof

☐ 4. Engaged in reading/reflection/written communication about mathematics or science:
☐ a. Read about mathematics/science
☐ b. Answered textbook/worksheet questions
☐ c. Reflected on readings, activities, or problems individually or in groups
☐ d. Prepared a written report
☐ e. Wrote a description of a plan, procedure, or problem-solving process
☐ f. Wrote reflections in a notebook or journal

☐ 5. Used technology/audio-visual resource:
☐ a. To develop conceptual understanding
☐ b. To learn or practice a skill
☐ c. To collect data (e.g., probeware)
☐ d. As an analytic tool (e.g., spreadsheets or data analysis)
☐ e. As a presentation tool
☐ f. For word processing or as a communications tool (e.g., e-mail, Internet, Web)

☐ 6. Other activities
☐ a. Arts and crafts activity
☐ b. Listened to a story
☐ c. Wrote a poem or story
☐ d. Other (Please specify.) ____

[5] "Major" means was used or addressed for a substantial portion of the lesson; if you were describing the lesson to someone, this feature would help characterize it.

D. Comments
Please provide any additional information you consider necessary to capture the activities or context of this lesson. Include comments on any feature of the class that is so salient that you need to get it "on the x " right away to help explain your ratings; for example, the class was interrupted by a fire drill, the kids were excited about an upcoming school event, or the teacher's tone was so warm (or so hostile) that it was an overwhelmingly important feature of the lesson. Be sure to distinguish use student and/or teacher use of technology (e.g., game play, teaching module, PPT).

SECTION TWO: RATINGS[6]

In Section One of this form, you documented what occurred in the lesson. In this section, you are asked to rate each of a number of key indicators in four different categories, from 1 (not at all) to 5 (to a great extent). You may list any additional indicators you consider important in capturing the essence of this lesson and rate these as well. Use your "Ratings of Key Indicators" (Part A) to inform your "Synthesis Ratings" (Part B). It is important to indicate in "Supporting Evidence for Synthesis Ratings" (Part C) what factors were most influential in determining your synthesis ratings and to give specific examples or quotes to illustrate those factors.

Note that any one lesson is not likely to provide evidence for every single indicator; use 6, "Don't know" when there is not enough evidence for you to make a judgment. Use 7, "N/A" (Not Applicable) when you consider the indicator inappropriate given the purpose and context of the lesson. Section Two concludes with ratings of the likely impact of instruction, and a capsule description of the lesson.

[6] Ratings for Section Two, Part III Mathematics Content were not included from Version 2 of the observation protocol for the purposes of this study.

I. Design

A. Ratings of Key Indicators

	Not at all				To a great extent	Don't Know	N/A
1. The design of the lesson incorporated tasks, roles, and interactions consistent the use of electronic games in mathematics instruction.	1	2	3	4	5	6	7
2. The design of the lesson reflected careful planning and organization.	1	2	3	4	5	6	7
3. The instructional strategies and activities used in this lesson reflected attention to students' experience, preparedness, and/or learning styles.	1	2	3	4	5	6	7
4. The resources available in this lesson contributed to accomplishing the purposes of the instruction.	1	2	3	4	5	6	7
5. The instructional strategies and activities reflected attention to issues of access, equity, and diversity for students (e.g., cooperative learning, language-appropriate strategies/ materials).	1	2	3	4	5	6	7
6. The design of the lesson encouraged a collaborative approach to learning.	1	2	3	4	5	6	7
7. Adequate time and structure were provided for use of Tabula Digita games.	1	2	3	4	5	6	7
8. Adequate time and structure were provided for wrap-up.							
9. Formal assessments of students were consistent with the use of technology in mathematics instruction.							
10. Design for future instruction takes into account what transpired in the lesson.							

B. Synthesis Rating

1	**2**	**3**	**4**	**5**
Design of the lesson not at all reflective of best practice in mathematics education				Design of the lesson extremely reflective of best practice in mathematics education

C. Supporting Evidence for Synthesis Rating

II. Implementation

A. Ratings of Key Indicators

	Not at all				To a great extent	Don't Know	N/A
1. The instruction was consistent with the underlying approach of the instructional materials designated for use by Tabula Digita (Lesson Plans).	1	2	3	4	5	6	7
2. The instructional strategies were consistent with the use of electronic games in mathematics instruction.	1	2	3	4	5	6	7
3. The teacher appeared confident in his/her ability to teach mathematics.	1	2	3	4	5	6	7
4. The teacher's classroom management style/strategies enhanced the quality of the lesson.	1	2	3	4	5	6	7
5. The pace of the lesson was appropriate for the developmental levels/needs of the students and the purposes of the lesson.	1	2	3	4	5	6	7
6. The teacher was able to "read" the students' level of understanding and adjusted instruction accordingly.	1	2	3	4	5	6	7
7. The teacher's questioning strategies were likely to enhance the development of student conceptual understanding/ problem solving (e.g., emphasized higher order questions, appropriately used "wait time," identified prior conceptions and misconceptions).	1	2	3	4	5	6	7
8. The lesson was modified as needed based on teacher questioning or other student assessments.	1	2	3	4	5	6	7

B. Synthesis Rating

1	**2**	**3**	**4**	**5**
Implementation of the lesson not at all reflective of best practice in mathematics education				Implementation of the lesson extremely reflective of best practice in mathematics education

C. Supporting Evidence for Synthesis Rating

IV. Classroom Culture

A1. Ratings of Key Indicators

	Not at all				To a great extent	Don't Know	N/A
1. Active participation of all was encouraged and valued.	1	2	3	4	5	6	7
2. There was a climate of respect for students' ideas, questions, and contributions.	1	2	3	4	5	6	7
3. Interactions reflected collegial working relationships among students (e.g., students worked together, talked with each other about the lesson).	1	2	3	4	5	6	7
4. Interactions reflected collaborative working relationships between teacher and students.	1	2	3	4	5	6	7
5. The climate of the lesson encouraged students to generate ideas, questions, conjectures, and/or propositions.	1	2	3	4	5	6	7
6. Intellectual rigor, constructive criticism, and the challenging of ideas were evident.	1	2	3	4	5	6	7
7. ____	1	2	3	4	5	6	7

A2. Respect for Diversity

Based on the culture of a classroom, observers are generally able to make inferences about the extent to which there is an appreciation of diversity among students (e.g., their gender, race/ethnicity, and/or cultural background). While direct evidence that reflects particular sensitivity or insensitivity toward diversity is not often observed, we would like you to document any examples you do see. If any examples were observed, please check here □ and describe below:

B. Synthesis Rating

1	2	3	4	5
Classroom culture interfered with student learning				Classroom culture facilitated the learning of all students

C. Supporting Evidence for Synthesis Rating

V. Overall Ratings of the Lesson

A. Likely Impact of Instruction on Students' Understanding of Mathematics/Science

While the impact of a single lesson may well be limited in scope, it is important to judge whether the lesson is likely to help move students in the desired direction. For this series of ratings, consider all available information (i.e., your previous ratings of design, implementation, content, and classroom culture, and the pre- and post-observation interviews with the teacher) as you assess the likely impact of this lesson. Feel free to elaborate on ratings with comments in the space provided.

Select the response that best describes your overall assessment of the *likely effect* of this lesson in each of the following areas.

Mixed or
Negative neutral Positive Don't
Effect effect effect know N/A

1. Students' understanding of mathematics as a dynamic body of knowledge generated and enriched by investigation.	O	O	O	O	O	O	O
2. Students' understanding of important mathematics concepts.	O	O	O	O	O	O	O
3. Students' capacity to carry out their own inquiries.	O	O	O	O	O	O	O
4. Students' ability to apply or generalize skills and concepts to other areas of mathematics, other disciplines, and/or real-life situations.	O	O	O	O	O	O	O
5. Students' self-confidence in doing mathematics.	O	O	O	O	O	O	O
6. Students' interest in and/or appreciation for the discipline.	O	O	O	O	O	O	O

Comments (optional):

B. Capsule Description of the Quality of the Lesson

In this final rating of the lesson, consider all available information about the lesson, its context and purpose, and your own judgment of the relative importance of the ratings you have made. Select the capsule description that best characterizes the lesson you observed. Keep in mind that this rating is *not* intended to be an average of all the previous ratings, but should encapsulate your overall assessment of the quality and likely impact of the lesson. Please provide a brief rationale for your final capsule description of the lesson in the space provided.

☐ **Level 1: Ineffective Instruction.** There is little or no evidence of student thinking or engagement with important ideas of mathematics. Instruction is *highly unlikely* to enhance students' understanding of the discipline or to develop their capacity to successfully "do" mathematics. Lesson was characterized by either (select one below):

☐ **Passive "Learning."** Instruction is pedantic and uninspiring. Students are passive recipients of information from the teacher or textbook; material is presented in a way that is inaccessible to many of the students.

☐ **Activity for Activity's Sake.** Students are involved in hands-on activities or other individual or group work, but it appears to be activity for activity's sake. Lesson lacks a clear sense of purpose and/or a clear link to conceptual development.

☐ **Level 2: Elements of Effective Instruction.** Instruction contains some elements of effective practice, but there are *serious problems* in the design, implementation, content, and/or appropriateness for many students in the class. For example, the content may lack importance and/or appropriateness; instruction may not successfully address the difficulties that many students are experiencing, etc. Overall, the lesson is *very limited* in its likelihood to enhance students' understanding of the discipline or to develop their capacity to successfully "do" mathematics.

☐ **Level 3: Beginning Stages of Effective Instruction** (Select one below).
☐ Low 3 ☐ Solid 3 ☐ High 3
Instruction is purposeful and characterized by quite a few elements of effective practice. Students are, at times, engaged in meaningful work, but there are *weaknesses*, ranging from substantial to fairly minor, in the design, implementation, or content of instruction. For example, the teacher may short-circuit a planned exploration by telling students what they "should have found"; instruction may not adequately address the needs of a number of students; or the classroom culture may limit the accessibility or effectiveness of the lesson. Overall, the lesson is *somewhat limited* in its likelihood to enhance students' understanding of the discipline or to develop their capacity to successfully "do" mathematics.

☐ **Level 4: Accomplished, Effective Instruction.** Instruction is purposeful and engaging for most students. Students actively participate in meaningful work (e.g., investigations, teacher presentations, discussions with each other or the teacher, reading). The lesson is well-designed and the teacher implements it well, but adaptation of content or pedagogy in response to student needs and interests is limited. Instruction is *quite likely* to enhance most students' understanding of the discipline and to develop their capacity to successfully "do" mathematics.

☐ **Level 5: Exemplary Instruction.** Instruction is purposeful and all students are highly engaged most or all of the time in meaningful work (e.g., investigation, teacher presentations, discussions with each other or the teacher, reading). The lesson is well-designed and artfully implemented, with flexibility and responsiveness to students' needs and interests. Instruction is *highly likely* to enhance most students' understanding of the discipline and to develop their capacity to successfully "do" mathematics.

Please provide your rationale for the capsule rating:

APPENDIX F: TEACHER INTERVIEW PROTOCOL

Teacher Interview Protocol

For the first 9 weeks, please:
- Ask Questions 1-14 to all teachers; and
- Ask Questions 15-30 to teachers in treatment groups (using TD games and materials).

For the second 9 weeks, please:
- Ask Question 12 to all teachers; and
- Ask Questions 15-30 to teachers in treatment groups (using TD games and materials).

The following information is to be used by the researcher before, during, and after the interview. The researchers follow these steps:

Before the interview

- Schedule a one hour meeting with the participant at least one week prior.
- Request permission ahead of time to tape the interview.
- Assure the participant that results will be kept confidential.
- When the researcher schedules the interview, provides the participant with the questions.
- Make sure to test recording equipment, including the microphone and volume.
- Have all materials organized and ready for the interview.
- Take extra batteries or an extension cord for your recording equipment.
- Make sure to bring a recorder and tape of high quality. (60-90 minute tape)

During the interview

- Before beginning the formal questions, the researcher records teacher's name, date, and school.
- Ask the questions as written, but if the participant seems to misinterpret the question or to get "off track" with his/her response, asks probing questions to clarify his/her response.
- Try to avoid a dialogue during the interview – lets the participant do the talking.
- In conclusion, asks the participant if she/he have any questions or comments.

After the interview

- Write up (or verbally attach) a brief report as soon as possible after the interview. Make sure to clarify any unusual occurrences (such as an interruption in the interview), or her impressions of strange responses from the participant. (e.g., Were there any questions that he/she seemed to find offensive or threatening? Were there any questions that seemed unusually difficult to answer?).
- Supplement notes by defining any special terms or explanations used that might not be known by the other universities.
- Describe any insights that may not have registered through the audio medium, or any other unusual occurrences during the meeting.

Interview Guide for Use by Researcher

Interviewer initials: _______ Date: _________ Time begin:_________ Time end:______
Folder #: __________

Introduce yourself and the purpose of the interview:
After I introduce myself and have the recorder started, I will read the following.
"Thank you for allowing me to come in today to talk about your Mathematics class(es). The purpose of our interview is not to grade or rank you, but to look at the factors that affect you as a Mathematics teacher. The interview will run about 60 minutes. Please be assured that the information you provide will be kept in strict confidentiality. Do you have any questions before we begin?"

Confidentiality:
What you say will be confidential. I won't connect your name with anything you say.
Please say what you really think - it's not a test:
Please remember, **there is no right or wrong answers**. It's not a test.
I didn't design the game, and you won't hurt my feelings, no matter what you say about it.
So please feel free to say what you think.

Any questions before we get started

APPENDIX G: PARENTAL INFORMED CONSENT

[Month, Day], 2007

Dear Parent/Guardian:

Your child's Mathematics class is participating in a study that is being conducted by professors at the University of Central Florida, College of Education. Your child's identifying information has not been shared in any way with the researcher at this time. Your child's class was chosen because it meets the criteria for this study and you, as a parent, are being offered the opportunity to have your child participate and being asked for your permission to participant

The research project involves determining the effects of a set of educational video games and related instructional materials on students' Mathematics achievement, Mathematics anxiety, and Mathematics course motivation. The researcher wants to document and write about the Mathematics class and the effects the video games have upon everyone in the class. The results of this study will help the school district make informed decisions about using these games district-wide, as well as help educators make better use of such instructional materials in the future. In addition, the results of this study will also help educational game designers create better games for students.

With your consent, your child's Mathematics scores on district and school Mathematics exams will be recorded. Your child will also be asked to complete a Game Preparation and Performance Check prepared by the game designer, and a questionnaire regarding your child's Mathematics anxiety and Mathematics class motivation to best gauge entry level benchmarks of your child's progress during this study. Your child's class will also be observed (once per nine-week term) and your child may be asked to be interviewed by researchers, such as a professor and/or a doctoral candidate at the University of Central Florida, once per school year. The class will NOT be videotaped. The interview will be held in the school office during non-instructional time and should take less than 30 minutes. The interview will be tape recorded for transcription purposes only. Tapes will be stored in a locked cabinet at the UCF and will be destroyed soon after the research process is complete.

Please Note: Your child's Mathematics scores and his/her responses to the Mathematics course motivation and Mathematics anxiety surveys will also be given to Tabula Digita (the game designers). However, your child's identity will be kept strictly confidential. In other words, your child's name or any other identifying information will **NOT** be released to Tabula Digita.

All identifying information will be replaced with alternate names or codes, only non-identifiable information will be released. By signing the consent form, you are also agreeing to allow us to release only non-identifiable data to Tabula Digita.

Your child's name, the names of his/her teachers, and the name of your child's school will be kept confidential and will not be used in any report, analysis, or publication by the researchers or by Tabula Digita. Again, all identifying information will be replaced with alternate names or codes. In addition, the researcher is requesting your permission to access your child's documents and school records such as those available in the cumulative file and his/her grades.

Your child will be allowed the right to refuse to answer any questions that make him/her uncomfortable, and he/she may stop participating in this research at any time. Your child will be reminded of this immediately prior to the interview. I have attached a copy of the interview questions for your information.

You may contact me at 407-823-1760 or email at hirumi@mail.ucf.edu, for any questions you have regarding the research procedures. Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (IRB). Questions or concerns about research participants' rights may be directed to the UCF IRB office, University of Central Florida, Office of Research & Commercialization, University Towers, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246, or by campus mail 32816-0150. The hours of operation are 8:00 am until 5:00 pm, Monday through Friday except on University of Central Florida official holidays. The telephone number is (407) 823-2901.

Sincerely,

Atsusi Hirumi, Ph.D.
Associate Professor and Co-Chair

Instructional Technology
University of Central Florida

The Effects of Modern Educational Computer Games

Parent/Caregiver Informed Consent

____ I have read the procedure described on the previous pages.

____ I have received a copy of this form to keep for my records.

____ I give consent for the primary researcher to interview my child's at the school with proper adult supervision.

____ I give consent for the primary researcher to have access to my child's cumulative folder, and grades.

____ I give consent for the online collection and use by Tabula Digita, and release of non-identifiable information to Tabula Digita.

I voluntarily give my consent for my child, ________________________, to participate in Dr. Hirumi's study entitled, "The Effects of Modern Mathematics Computer Games on Student Mathematics Achievement, Mathematics Anxiety and Motivation."

_________________________________ /____________

Parent/Guardian Date

_________________________________ /____________

2nd Parent/Guardian Date

(or Witness if no 2nd Parent/Guardian)

Please sign and return one copy of this page and ask your child to return it to class.

APPENDIX H: TEACHER INFORMED CONSENT

August, 2007

Dear Educator:

My name is Dr. Atsusi Hirumi, and I am an Associate Professor and Co-Chair of the Instructional Technology at the University of Central Florida. As part of my research, I am asking teachers at several Middle Schools and a High School in Orange County Public Schools to participate.

The purpose of the research study is to determine the effects of educational video games and related instructional materials on students' Mathematics achievement, Mathematics anxiety, and Mathematics course motivation. The researcher wants to document and write about your Mathematics class and the effects the video games had on everyone in the class. The results of this study will help the school district make informed decisions about using the game, as well as help educators make better use of such instructional materials. The results will also help educational game designers create better games and supporting instructional materials for teachers and students.

With your consent, students in your Mathematics classes will be asked to volunteer for the study. Of those students who volunteer and sign (or have their parents/caregivers sign) a similar consent form, scores on district and school Mathematics exams will be recorded. Participating students will also be asked to complete a questionnaire regarding their Mathematics anxiety and Mathematics class motivation at the beginning, mid, and end of the school year. Your class will also be observed (once per nine-week term) and you and some of your students may be asked to be interviewed by researchers, a professor and/or a doctoral candidate at the University of Central Florida. Your class will NOT be videotaped. The interviews will be held in the school office during non-instructional time and should take less than 30 minutes. The interview will be tape recorded for transcription purposes only. All data, including tapes, completed observation forms, Mathematics achievement scores, and responses to Mathematics anxiety and Mathematics course motivation questionnaires will be stored in a locked cabinet in my research and development laboratory at UCF (Teaching Academy Room 321) and will be destroyed soon after the research process is complete.

Please Note: Data will be given to Tabula Digita (the game designers), but only in non-identifiable format. In other words, scores on Mathematics achievement tests and Mathematics course motivation and anxiety surveys will be given, but no names will **NOT** be given to Tabula Digita. All identifying information will be replaced with alternate names or codes. By signing the consent form, you are also agreeing to allow us to release the data to Tabula Digita.

Your name, the names of your students, and the name of your school will be kept confidential and will not be used in any report, analysis, or publication by the researchers or Tabula Digita. Again, all identifying information will be replaced with alternate names or codes. In addition, the researcher is requesting your permission to access participating students' documents and school records such as those available in the cumulative file, and students' grades.

There are no anticipated risks, compensation or other direct benefits to you as a participant in this interview. You are free to withdraw your consent to participate and may discontinue your participation in the interview at any time without consequence.

If you have any questions about this research project, please contact me at (407) 823-1760 or by email at hirumi@mail.ucf.edu. Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (IRB). Questions or concerns about research participants' rights may be directed to the Institutional Review Board Office, IRB Coordinator, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246. The telephone number is (407) 823-2901.

Please sign and return this copy of the letter to the Research assigned to your school. A second copy is provided for your records. By signing this letter, you give me permission to report the information about your students' Mathematics achievement, Mathematics anxiety, Mathematics course motivation, along with observation and interview data noted in the letter as part of my research.

Sincerely,

Atsusi Hirumi, Ph.D.
Associate Professor and Co-Chair
Instructional Technology
University of Central Florida
407.823.1760
Hirumi@mail.ucf.edu

The Effects of Modern Educational Computer Games

Teacher Informed Consent

____ I have read the procedure described above for the research study.

____ I voluntarily agree to participate in the study.

____ I agree to be audio taped during the interview.

____ I give consent for the online collection and use by Tabula Digita, and the release of ***non-identifiable*** information (only) to Tabula Digita.

______________________________________/________________

Participant Date

______________________________________/________________

Principal Investigator Date

APPENDIX I: STUDENT INTERVIEW

Student Interview Questions

1. Name: ______________________________ 2. Teacher: _____________________________

3. Class/Period___________________________ 4. School: _______________________________

Please think about your current Mathematics class(es). Think about your teacher and how she or he teaches the class, as well as the programs and other materials you use in class.

5. What specific parts of your Mathematics class catches and keeps your attention?

6. What specific parts of your Mathematics class do you think are important/relevant to your personal life and/or interests?

7. What specific parts of your Mathematics class increased your confidence to do Mathematics and do well in Mathematics class?

8. What specific parts of learning Mathematics and of your Mathematics class do you think are worth your time and effort?

9. What specific parts of your Mathematics class do you think helps you learn Mathematics in general, and do better on the Mathematics section of the FCAT test?

10. What specific parts of your Mathematics class either motivates you to learn or has a bad effect on your motivation to learn?

For students in treatment group only

11. Which game did YOU play and about how much of the each game did YOU play?

	All of it	Most of it	Some of it	Very little	Did not play
O N/A (Not Applicable)					
Not sure which game(s), but I did play…	O	O	O	O	O
Evolver (Single Player Pre-Algebra Game)	O	O	O	O	O
Dimenxian (Single Player Algebra Game)	O	O	O	O	O
Swarm (Multi-Player Game)	O	O	O	O	O
Obstacle Course (Multi-Player Game)	O	O	O	O	O
Meltdown (Multi-Player Game)	O	O	O	O	O

12. Compared to other forms of Mathematics school work (e.g., worksheets, home work assignments), do you like playing Tabula Digita's Mathematics Games?

1	2	3	4	5
A lot Less	Less	About the same	More	A lot More

13. Compared to other entertaining video games, do you like playing Tabula Digita's Mathematics Games?

1	2	3	4	5
A lot Less	Less	About the same	More	A lot More

14. What did you like or dislike about the game(s)?

15. Do you feel that playing the Mathematics video game(s) helped you understand Mathematics concepts and increase your Mathematics skills?

1	2	3	4	5
Not, not at all	No	Somewhat	Yes	Yes, very much

16. Did any of the following effect your desire to play the Mathematics games?

	No effect	Little effect	Some effect	Significant effect	Great effect
Your Mathematics skills	O	O	O	O	O
Your computer skills	O	O	O	O	O

Your English skills	O	O	O	O	O

17. Did any of the following effect your learning from the Mathematics games?

	No effect	Little effect	Some effect	Significant effect	Great effect
Your Mathematics skills	O	O	O	O	O
Your computer skills	O	O	O	O	O
Your English skills	O	O	O	O	O

18. Did you play the single player AND multi-player games? If not, skip this question and go to question #11. If yes, which one did you prefer and why? Which one increased your Mathematics skills more and why?

19.Was it easy for you to learn how to play the Mathematics game(s)?

1	2	3	4	5
No, they were very difficult to learn	No	Somewhat	Yes	Yes, they were very easy to learn

20. What specific problems, if any, did you have in learning how to play the game?

21. Do you think boys or girls like to play the Mathematics game more or is the interest in the Mathematics games the same for both? Why?

22. What specific aspects of the game did you enjoy the most?

23. What specific aspect of the game did you dislike the most?

24. How would you improve the games?

25. Do you have any additional questions or comments?

Thank you for your time and comments!

APPENDIX J: TEACHER INTERVIEW

Teacher Interview

1. Name: ________________ 2. Gender: a. Male | b. Female

3. Ethnicity: a. White | b. African American | c. Hispanic | d. Asian | e. Other _____________

4. Birthday:
   - O before 1945 (Silent Generation)
   - O 1945-1960 (Baby Boomers)
   - O 1961-1979 (Gen X)
   - O 1980 (Digital Natives)

5. Highest Degree and Area:
   - O Associates in ___________________________
   - O Bachelors in ____________________________
   - O Masters in ______________________________
   - O Specialization in _________________________
   - O Doctorate in ____________________________

6. Mathematics Certification
   - O None
   - O Temporary
   - O Professional

7. Certification Level
   - O N/A
   - O Grades 5-9
   - O Grades 6-12

8. How many years have you been teaching Math?
   - O This is my first year
   - O One year
   - O Two-Five years
   - O Six-Ten years
   - O Over Ten years

9. Which Mathematics subjects do you teach and to what extent do you enjoy teaching each subject?

	One of my favorites		It's OK		Really do not enjoy it
O 7h Grade (Regular)	O	O	O	O	O
O 7h Grade (Advanced)	O	O	O	O	O
O Pre-Algebra	O	O	O	O	O

O Algebra	O	O	O	O	O
O Algebra (Honors)	O	O	O	O	O
O Geometry	O	O	O	O	O
O Other ____________________	O	O	O	O	O
O Other ____________________	O	O	O	O	O

10. On a scale from 1-5, How would you characterize your teaching method (circle a number)?

1	2	3	4	5
Directed Teacher-Centered				Inquiry/Investigative Student-Centered

11. In your opinion, what distinguishes Inquiry/Investigative Student Centered instructional methods from Directed, Teacher-Center methods?

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12. Other then Tabula Digita Mathematics Games, what innovative programs are you currently using in your class (if any)? How often do you use each program?

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13. Approximately how often do you play video games each week?
   - O Every day
   - O 3-5 times per week
   - O 1-2 times per week
   - O Not very often
   - O Not at all

14. How would you rate your computer skills (NOT considering your video game playing skills)?
   - O Awesome, power user
   - O Proficient, regular user

- O Novice, infrequent user
- O Beginning, just started user
- O Non-user

Treatment Group (Teachers Using Tabula Digita Games and Products Only

15. Which of the following Tabula Digita Mathematics Games did you use with students prior to Fall 2007?
    - O None
    - O Evolver (Single Player PreAlgebra)
    - O Dimenxian (Single Player Algebra)
    - O Swarm (Multi-Player)
    - O Obstacle Course (Multi-Player)
    - O Meltdown (Multi-Player)

16. Which game did YOU play and approximately how much of the each game did YOU play?

	Did not play	Very little	Some of it	Most of it	All of it
O N/A (Not Applicable)					
Not sure which game(s), but I did play…	O	O	O	O	O
Evolver (Single Player Pre-Algebra Game)	O	O	O	O	O
Dimenxian (Single Player Algebra Game)	O	O	O	O	O
Swarm (Multi-Player Game)	O	O	O	O	O
Obstacle Course (Multi-Player Game)	O	O	O	O	O
Meltdown (Multi-Player Game)	O	O	O	O	O

17. Which of the following DimensionM Mathematics games did you use WITH STUDENTS?

	Did not use	Very little of it	Some of it	Most of it	All of it
O N/A (Not Applicable)					
Evolver (Single Player Pre-Algebra Game)	O	O	O	O	O
Dimenxian (Single Player Algebra Game)	O	O	O	O	O
Swarm (Multi-Player Game)	O	O	O	O	O
Obstacle Course (Multi-Player Game)	O	O	O	O	O
Meltdown (Multi-Player Game)	O	O	O	O	O

18. Please rate the impact of each game on student Mathematics achievement?

	Great Negative	Some Negative	No Impact	Some Positive	Great Positive
O N/A (Not Applicable)					
Evolver (Single Player Pre-Algebra Game)	O	O	O	O	O
Dimenxian (Single Player Algebra Game)	O	O	O	O	O
Swarm (Multi-Player Game)	O	O	O	O	O
Obstacle Course (Multi-Player Game)	O	O	O	O	O

Meltdown (Multi-Player Game)	O	O	O	O	O

19. Please rate the impact of each game on student motivation to learn?

	Great Negative	Some Negative	No Impact	Some Positive	Great Positive
O N/A (Not Applicable)					
Evolver (Single Player Pre-Algebra Game)	O	O	O	O	O
Dimenxian (Single Player Algebra Game)	O	O	O	O	O
Swarm (Multi-Player Game)	O	O	O	O	O
Obstacle Course (Multi-Player Game)	O	O	O	O	O
Meltdown (Multi-Player Game)	O	O	O	O	O

20. Please rate the impact of each factor on student learning from gameplay.

	Great Negative	Some Negative	No Impact	Some Positive	Great Positive
O N/A (Not Applicable)					
Students' Mathematics preexisting knowledge	O	O	O	O	O
Students' computer skills	O	O	O	O	O
Students' English skills	O	O	O	O	O

21. How often did you use each of the following DimensionM supplemental products?

	Not at all	A few times	Some-times	Often	Very Often
O N/A (Not Applicable)					
Educator Portal	O	O	O	O	O
Online Instructional Modules	O	O	O	O	O
Teacher-Directed Lesson Plans	O	O	O	O	O
Inquiry-Based Lesson Plans	O	O	O	O	O
MS PowerPoints	O	O	O	O	O
Handouts	O	O	O	O	O
Quizzes	O	O	O	O	O

22. Please rate the value of each of the following DimensionM supplemental products.

	No	Little	Some	Signifi-cant	Great
O N/A (Not Applicable)					
Teacher Portal	O	O	O	O	O
Online Teaching Modules	O	O	O	O	O
Teacher-Directed Lesson Plans	O	O	O	O	O
Inquiry-Based Lesson Plans	O	O	O	O	O
MS PowerPoints	O	O	O	O	O
Handouts	O	O	O	O	O
Quizzes	O	O	O	O	O

23. To what degree do you believe the Tabula Digita Mathematics games correlate to district benchmark and state FCAT exams?

1	2	3	4	5
No Correlation	Little Correlation	Some Correlation	Correlation	High Correlation

24. What factors affect the use and integration of Mathematics games and/or other innovative programs in your class?

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25. Have you witnessed any differences in game play based on gender, please explain?

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26. Does one gender appear more or less comfortable with playing the Mathematics video games?

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27. When you think about using DimensionM™ with students, what is your ONE greatest concern?

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28. Do you believe that you could significantly improve students' Mathematics scores next year using DimensionM™ games and supplemental products? In other words, now that you've had experience using DimensionM™ games and supplemental products, do you think you can significantly improve students' Mathematics scores? Yes | No? Why or Why not?

29. What recommendations do you have for improving DimensionM products and services?

30. Do you any additional questions or comments?

Thank You for Your Time and Insights. They are greatly appreciated!

APPENDIX K: GAME PLAYER BACKGROUND AND MOTIVATION

Game Player Background and Motivation

Please fill in the appropriate circle on the BACK of the SCANTRON, starting with #51

51. Are you male or female?
A. Male
B. Female

52. What is your ethnicity?
A. Caucasian
B. African American
C. Hispanic
D. Asian
E. Other

53. Approximately how often do you play *entertaining* video games each week?
A. Every day
B. 3-5 times per week
C. 1-2 times per week
D. Not very often
E. Not at all

Approximately how much of each of the following games have you played?

		All of it	Most of it	Some of it	Very little	Have not played
54.	Evolver (Single Player Pre-Algebra Game)	A	B	C	D	E
55.	Dimenxian (Single Player Algebra Game)	A	B	C	D	E
56.	Swarm (Multi-Player Game)	A	B	C	D	E
57.	Obstacle Course (Multi-Player Game)	A	B	C	D	E
58.	Meltdown (Multi-Player Game)	A	B	C	D	E

59. Do you have a computer connected to the Internet at home?
A. Yes
B. No

60. Approximately how often do you use the computer to do school work at home video?
A. Every day
B. 4-6 times per week
C. 1-3 times per week
D. Not very often
E. Not at all

61. How would you rate your computer skills (NOT considering game playing skills)?
A. Awesome, power user
B. Proficient, regular user

C. Novice, infrequent user
D. Beginning, just started user
E. Non-user

APPENDIX L: MATHEMATICS 2 BENCHMARKS

Florida Department of Education – Mathematics 2 Course Description Benchmarks retrieved from
http://www.floridastandards.org/Courses/PublicPreviewCourse27.aspx?kw=mathematics

GENERAL INFORMATION

Course Number:	1205040
Course Path:	**Section:** Basic and Adult Education » **Grade Group:** Middle School Grades 6-8 » **Subject:** Mathematics » **SubSubject:** General Mathematics »
Course Title:	M/J Mathematics 2
Course Section:	Basic and Adult Education
Abbreviated Title:	M/J MATH 2
Number of Credits:	NA
Course Length:	Year
Course Type:	Core
Course Level:	2
Course Status:	State Board Approved

RELATED BENCHMARKS (24) :

Scheme	Descriptor	DOK Rating
LA.7.1.6.5	The student will relate new vocabulary to familiar words;	
LA.7.3.2.2	The student will draft writing by organizing information into a logical sequence and combining or deleting sentences to enhance clarity; and	
MA.7.A.1.1	Distinguish between situations that are proportional or not proportional, and use proportions to solve problems.	High
MA.7.A.1.2	Solve percent problems, including problems involving discounts, simple interest, taxes, tips, and percents of increase or decrease.	High
MA.7.A.1.3	Solve problems involving similar figures.	High
MA.7.A.1.4	Graph proportional relationships and identify the unit rate as the slope of the related linear function.	Moderate
MA.7.A.1.5	Distinguish direct variation from other relationships, including inverse variation.	Moderate
MA.7.A.1.6	Apply proportionality to measurement in multiple contexts, including scale drawings and constant speed.	Moderate
MA.7.A.3.1	Use and justify the rules for adding, subtracting, multiplying, dividing, and finding the absolute value of integers.	Moderate

MA.7.A.3.2	Add, subtract, multiply, and divide integers, fractions, and terminating decimals, and perform exponential operations with rational bases and whole number exponents including solving problems in everyday contexts.	Moderate
MA.7.A.3.3	Formulate and use different strategies to solve one-step and two-step linear equations, including equations with rational coefficients.	Moderate
MA.7.A.3.4	Use the properties of equality to represent an equation in a different way and to show that two equations areÂ equivalent in a given context.	Moderate
MA.7.A.5.1	Express rational numbers as terminating or repeating decimals.	Low
MA.7.A.5.2	Solve non-routine problems by working backwards.	High
MA.7.G.2.1	Justify and apply formulas for surface area and volume of pyramids, prisms, cylinders, and cones.	Moderate
MA.7.G.2.2	Use formulas to find surface areas and volume of three-dimensional composite shapes.	Moderate
MA.7.G.4.1	Determine how changes in dimensions affect the perimeter, area, and volume of common geometric figures, and apply these relationships to solve problems.	High
MA.7.G.4.2	Predict the results of transformations, and draw transformed figures with and without the coordinate plane.	Moderate
MA.7.G.4.3	Identify and plot ordered pairs in all four quadrants of the coordinate plane.	Low
MA.7.G.4.4	Compare, contrast, and convert units of measure between different measurement systems (US customary or metric (SI)), dimensions, and derived units to solve problems.	High
MA.7.P.7.1	Determine the outcome of an experiment and predict which events are likely or unlikely, and if the experiment isÂ fair or unfair.	Moderate
MA.7.P.7.2	Determine, compare, and make predictions based on experimental or theoretical probability of independent or dependent events,	High
MA.7.S.6.1	Evaluate the reasonableness of a sample to determine the appropriateness of generalizations made about the population.	High
MA.7.S.6.2	Construct and analyze histograms, stem-and-leaf plots, and circle graphs.	Moderate

RELATED GLOSSARIES(74)

Absolute value	A number's distance form zero on a number line. Distance is expressed as a positive value.
Area	The number of square units needed to cover a surface.
Benchmark	A point of reference from which other measurements or values may be made or judged.
Circle graph	A data display that divides a circle into regions representation a portion to the total set of data. The circle represents the whole set of data.
Circumference	The distance around a circle.
Coefficient	The number that multiplies the variable(s) in an algebraic expression (e.g., 4xy). If no number is specified, the coefficient is 1.
Cone	A pyramid with a circular base.
Congruent	Figures or objects that are the same shape and size.
Constant	Any value that does not change.
Coordinate plane	A two-dimensional network of horizontal and vertical lines that are parallel and evenly-spaced; especially designed for locating points, displaying data, or drawing maps.
Cylinder	A three dimensional figure with two parallel congruent circular bases and a lateral surface that connects the boundaries of the bases. More general definitions of cylinder may not require circular bases.
Dependent events	Two events are dependent if the outcome of one event affects the probability that the other event will occur.
Derived units	Units of measurement of a derived quantity in a given system of quantities. Derived units are expressed algebraically in terms of base units by means of mathematical symbols of multiplication and division. (e.g., mph)
Dimension	The number of coordinates used to express a position.
Direct variation	The relation between two quantities whose ratio remains constant. If x is directly proportional to y, the equation is of the form $x = ky$, where k is a constant.
Discount	An amount that is subtracted from the regular price of an item.
Equal	Having the same value (=).
Equality	A mathematical statement of the equivalence of two quantities. Equivalence properties of equality includes reflexive (a=a), symmetric (if a=b, then b=a), and transitive (if a=b and b=c, then a=c) properties. A balanced equation will remain balanced if you add, subtract, multiply or divide (excluding

	division by zero) both sides by the same number.
Equation	A mathematical sentence stating that the two expressions have the same value. Also read the definition of equality.
Equivalent	Having the same value.
Event	A set of possible outcomes.
Expression	A mathematical phrase that contains variables, functions, numbers, and/or operations. An expression does not contain equal or inequality signs.
Factor	A number or expression that is multiplied by one or more other numbers or expressions to yield a product.
Formula	A rule that shows the relationship between two or more quantities; involving numbers and/or variables.
Histogram	A bar graph that shows how many data values fall into a certain interval. The number of data items in an interval is a frequency. The width of the bar represents the interval, while the height indicates the number of data items, or frequency, in that interval.
Instantaneous Rate of Change	The rate of change at a particular moment. For a function, the instantaneous rate of change at a point is the same as the slope of the tangent line at that point.
Integers	The numbers in the set {â€¦-4, -3, -2, -1, 0, 1, 2, 3, 4â€¦}.
Inverse variation	A relationship between two variables, x and y, that can be expressed as , where k is the constant of variation. When one variable increases the other decreases in proportion.
Length	A one-dimensional measure that is the measurable property of line segments.
Linear function	A relationship between two variables such that for a fixed change in one variable, there is fixed change in the other variable. If there is one independent variable (e.g. f(x)=mx+b), then the graph of the function will be a line. If there are two independent variables (e.g. f(x,y)=ax+by+c) then the graph of the function will be a plane.
Mean	There are several statistical quantities called means, e.g., harmonic mean, arithmetic mean, and geometric mean. However, â€œmeanâ€• commonly refers to the arithmetic mean that is also called arithmetic average. Arithmetic mean is a mathematical representation of the typical value of a series of numbers, computed as the sum of all the numbers in the series divided by the count of all numbers in the series. Arithmetic mean is the balance point if the numbers are considered as weights on a beam.

Median	When the numbers are arranged from least to greatest, the middle number of a set of numbers, or the mean of two middle numbers when the set has two middle numbers is called median. Half of the numbers are above the median and half are below it.
Mode	The most frequent value(s) of a set of data. A data set may have more than one mode if two or more data values appear the most. When no data value occurs more than once in a data set, there is no mode.
Multiples	The numbers that result from multiplying a given whole number by the set of whole numbers.
Non-routine problem	A problem that can be solved by more than one way, rather than a set procedure, having multiple decision points and multiple steps (grade level dependent).
Operation	Any mathematical process, such as addition, subtraction, multiplication, division, raising to a power, or finding the square root.
Ordered pair	The location of a single point on a rectangular coordinate system where the first and second values represent the position relative to the x-axis and y-axis, respectively.
Outcome	A possible result of an experiment.
Pattern	A predictable or prescribed sequence of numbers, objects, etc. Patterns and relationships may be described or presented using multiple representations such as manipulatives, tables, graphics (pictures or drawings), or algebraic rules (functions).
Percent	Per hundred; a special ratio in which the denominator is always 100. The language of percent may change depending on the context. The most common use is in part-whole contexts, for example, where a subset is 40 percent of another set. A second use is change contexts, for example, a set increases or decreases in size by 40 percent to become 140% or 60% of its original size. A third use involves comparing two sets, for example set A is 40% of the size of set B, in other words, set B is 250 percent of set A.
Perimeter	The distance around a two dimensional figure.
Plot	To locate a point by means of coordinates, or a curve by plotted points, or to represent an equation by means of a curve so constructed.
Point	A specific location in space that has no discernable length or width.
Prism	A polyhedron that has two congruent and parallel faces joined

	by faces that are parallelograms.
Probability	A measure of the likelihood that a given event will occur; expressed as a ratio of one event occurring (favorable outcomes) to the number of equally likely possible outcomes (sample space). Probability is expressed on a linear scale from 0 (impossibility) to 1 (certainty), also expressed as a percentage between 0 and 100%. Experimental probability of an event A is the ratio of the number of times the event A occurs to the total number of trials or times the activity is performed. Theoretical probability of an event A is the ratio of the number of outcomes in event A to the number of outcomes in the sample space.
Proportion	A mathematical sentence stating that two ratios are equal.
Proportional	Having the same or a constant ratio. Two quantities that have the same ratio are considered directly proportional. Two quantities whose products are always the same are considered inversely proportional.
Pyramid	A three-dimensional figure whose base is a polygon and whose faces are triangles with a common vertex.
Quadrant	Any polygon with four sides, including parallelogram, rhombus, rectangle, square, trapezoid, kite.
Rate	A ratio that compares two quantities of different units.
Rectangle	A parallelogram with four right angles.
Reflection	A transformation that produces the mirror image of a geometric figure over a line of reflection, also called a flip.
Relation	A relation from A to B is any subset of the cross product (Cartesian product) of A and B.
Representations	Physical objects, drawings, charts, words, graphs, and symbols that help students communicate their thinking.
Rotation	A transformation of a figure by turning it about a center point or axis. The amount of rotation is usually expressed in the number of degrees (e.g., a 90Â° rotation). Also called a turn.
Rule	A general statement written in numbers, symbols, or words that describes how to determine any term in a pattern or relationship. Rules or generalizations may include both recursive and explicit notation. In the recursive form of pattern generalization, the rule focuses on the rate of change from one element to the next. Example: Next = Now + 2; Next = Now x 4. In the explicit form of pattern generalization, the formula or rule is related to the order of the terms in the sequence and focuses on the relationship between the independent variable

	and the dependent variable. For example: y=5t - 3 Words may also be used to write a rule in recursive or explicit notation. Example: to find the total fee, multiply the total time with 3; take the previous number and add two to get the next number.
Scale	The numeric values, set at fixed intervals, assigned to the axes of a graph.
Set	A set is a finite or infinite collection of distinct objects in which order has no significance.
Side	The edge of a polygon (e.g., a triangle has three sides), the face of a polyhedron, or one of the rays that make up an angle.
Similar figures	Figures that are the same shape, have corresponding, congruent angle's and have corresponding sides that are proportional in length.
Transformation	An operation on a figure by which another image is created. Common transformations include reflections (flips), translations (slides), rotations (turns) and dilations.
Triangle	A polygon with three sides.
Unit	A determinate quantity (as of length, time, heat, or value) adopted as a standard of measurement.
Circle	A closed plane figure with all points of the figure the same distance from the center. The equation for a circle with center (h, k) and radius r is: $(x - h)^2 + (y - k)^2 = r^2$
Exponent (exponential form)	The number of times the base occurs as a factor, for example 2^3 is the exponential form of 2 x 2 x 2. The number two (2) is called the base, and the number three (3) is called the exponent.
Fraction	A rational number expressed in the form $^a/_b$, where a is called the numerator and b is called the denominator. A fraction may mean part of a whole, ratio of two quantities, or may imply division.
Pi	The symbol designating the ratio of the circumference of a circle to its diameter. It is an irrational number with common approximations of either 3.14 of 22/7.
Ratio	The comparison of two quantities, the ratio of a and b is a:b or a to b or a/b, where $b \neq 0$.
Rational Number	A number that can be expressed as a ratio a/b, where a and b are integers and $b \neq 0$.
Slope	The ratio of change in the vertical axis (y-axis) to each unit change in the horizontal axis (x-axis) in the form rise/run or ?y/?x. Also the constant, *m*, in the linear equation for the

	slope-intercept form *y* =*mx* + *b*, where $m = \frac{y_1 - y_2}{x_1 - x_2}$
Vertex	The point common to the two rays that form an angle; the point common to any two sides of a polygon; the point common to three or more edges of a polyhedron.
Volume	The amount of space occupied in three dimensions and expressed in cubic units.
Whole Number	The numbers in the set {0, 1, 2, 3, 4, ...}
Width	The shorter length of a two-dimensional figure. The width of a box is the horizontal distance from side to side (usually defined to be greater than the depth, the horizontal distance from front to back).

APPENDIX M: MATHEMATICS 2 ADVANCED BENCHMARKS

Florida Department of Education – Mathematics 2 Advanced Course Description
Benchmarks retrieved from:
http://www.floridastandards.org/Courses/PublicPreviewCourse28.aspx?kw=mathematics

GENERAL INFORMATION

Course Number:	1205050
Course Path:	**Section:** Basic and Adult Education » **Grade Group:** Middle School Grades 6-8 » **Subject:** Mathematics » **SubSubject:** General Mathematics »
Course Title:	M/J Mathematics 2, Advanced
Course Section:	Basic and Adult Education
Abbreviated Title:	M/J MATH 2, ADV
Number of Credits:	NA
Course Length:	Year
Course Type:	Core
Course Level:	3
Course Status:	State Board Approved

RELATED BENCHMARKS (31) :

Scheme	Descriptor	DOK Rating
LA.7.1.6.5	The student will relate new vocabulary to familiar words;	
LA.7.3.2.2	The student will draft writing by organizing information into a logical sequence and combining or deleting sentences to enhance clarity; and	
MA.7.A.1.1	Distinguish between situations that are proportional or not proportional, and use proportions to solve problems.	High
MA.7.A.1.2	Solve percent problems, including problems involving discounts, simple interest, taxes, tips, and percents of increase or decrease.	High
MA.7.A.1.3	Solve problems involving similar figures.	High
MA.7.A.1.4	Graph proportional relationships and identify the unit rate as the slope of the related linear function.	Moderate
MA.7.A.1.5	Distinguish direct variation from other relationships, including inverse variation.	Moderate
MA.7.A.1.6	Apply proportionality to measurement in multiple contexts, including scale drawings and constant speed.	Moderate
MA.7.A.5.1	Express rational numbers as terminating or repeating	Low

	decimals.	
MA.7.G.2.1	Justify and apply formulas for surface area and volume of pyramids, prisms, cylinders, and cones.	Moderate
MA.7.G.4.1	Determine how changes in dimensions affect the perimeter, area, and volume of common geometric figures, and apply these relationships to solve problems.	High
MA.7.G.4.2	Predict the results of transformations, and draw transformed figures with and without the coordinate plane.	Moderate
MA.7.G.4.3	Identify and plot ordered pairs in all four quadrants of the coordinate plane.	Low
MA.7.P.7.1	Determine the outcome of an experiment and predict which events are likely or unlikely, and if the experiment isÂ fair or unfair.	Moderate
MA.7.P.7.2	Determine, compare, and make predictions based on experimental or theoretical probability of independent or dependent events,	High
MA.7.S.6.1	Evaluate the reasonableness of a sample to determine the appropriateness of generalizations made about the population.	High
MA.7.S.6.2	Construct and analyze histograms, stem-and-leaf plots, and circle graphs.	Moderate
MA.8.A.1.1	Create and interpret tables, graphs, and models to represent, analyze, and solve problems related to linear equations, including analysis of domain, range, and the difference between discrete and continuous data.	High
MA.8.A.1.2	Interpret the slope and the x- and y-intercepts when graphing a linear equation for a real-world problem.	Moderate
MA.8.A.1.6	Compare the graphs of linear and non-linear functions for real-world situations.	Moderate
MA.8.A.4.2	Solve and graph one- and two-step inequalities in one variable.	Moderate
MA.8.A.6.1	Use exponents and scientific notation to write large and small numbers and vice versa and to solve problems.	Low
MA.8.A.6.2	Make reasonable approximations of square roots and mathematical expressions that include square roots, and use them to estimate solutions to problems and to compare mathematical expressions involving real numbers and radical expressions.	Moderate

MA.8.A.6.3	Simplify real number expressions using the laws of exponents.	Moderate
MA.8.A.6.4	Perform operations on real numbers (including integer exponents, radicals, percents, scientific notation, absolute value, rational numbers, and irrational numbers) using multi-step and real world problems.	High
MA.8.G.2.2	Classify and determine the measure of angles, including angles created when parallel lines are cut by transversals.	Low
MA.8.G.2.3	Demonstrate that the sum of the angles in a triangle is 180-degrees and apply this fact to find unknown measure of angles and the sum of angles in polygons.	Moderate
MA.8.G.2.4	Validate and apply Pythagorean Theorem to find distances in real world situations or between points in the coordinate plane.	Moderate
MA.8.G.5.1	Compare, contrast, and convert units of measure between different measurement systems (US customary or metric (SI)) and dimensions including temperature, area, volume, and derived units to solve problems.	High
MA.8.S.3.1	Select, organize, and construct appropriate data displays, including box and whisker plots, scatter plots, and lines of best fit to convey information and make conjectures about possible relationships.	Moderate
MA.8.S.3.2	Determine and describe how changes in data values impact measures of central tendency.	Moderate

RELATED GLOSSARIES(93)

Absolute value	A number's distance form zero on a number line. Distance is expressed as a positive value.
Angle	Two rays or two line segments extending from a common end point called a vertex. Angles are measured in degrees, in radians, or in gradians.
Area	The number of square units needed to cover a surface.
Benchmark	A point of reference from which other measurements or values may be made or judged.
Central tendency	A measure used to describe data (e.g., mean, mode, median).
Circle graph	A data display that divides a circle into regions representation a portion to the total set of data. The circle represents the whole set of data.
Circumference	The distance around a circle.

Cone	A pyramid with a circular base.
Congruent	Figures or objects that are the same shape and size.
Constant	Any value that does not change.
Continuous data	Data that can take any of an infinite number of values between whole numbers and so may not be measured completely accurately.
Continuous function	A function with a connected graph. A function f(x) is continuous at x=a if the limit of f(x) as x approaches to a exists and is equal to f(a).
Coordinate plane	A two-dimensional network of horizontal and vertical lines that are parallel and evenly-spaced; especially designed for locating points, displaying data, or drawing maps.
Cylinder	A three dimensional figure with two parallel congruent circular bases and a lateral surface that connects the boundaries of the bases. More general definitions of cylinder may not require circular bases.
Dependent events	Two events are dependent if the outcome of one event affects the probability that the other event will occur.
Derived units	Units of measurement of a derived quantity in a given system of quantities. Derived units are expressed algebraically in terms of base units by means of mathematical symbols of multiplication and division. (e.g., mph)
Difference	A number that is the result of subtraction
Dimension	The number of coordinates used to express a position.
Direct variation	The relation between two quantities whose ratio remains constant. If x is directly proportional to y, the equation is of the form $x = ky$, where k is a constant.
Discount	An amount that is subtracted from the regular price of an item.
Domain	The set of values of the independent variable(s) for which a function or relation is defined.
Equation	A mathematical sentence stating that the two expressions have the same value. Also read the definition of equality.
Estimate	Is an educated guess for an unknown quantity or outcome based on known information. An estimate in computation may be found by rounding, by using front-end digits, by clustering, or by using compatible numbers to compute.
Event	A set of possible outcomes.
Expression	A mathematical phrase that contains variables, functions, numbers, and/or operations. An expression does not contain

	equal or inequality signs.
Factor	A number or expression that is multiplied by one or more other numbers or expressions to yield a product.
Formula	A rule that shows the relationship between two or more quantities; involving numbers and/or variables.
Height	A line segment extending from the vertex or apex of a figure to its base and forming a right angle with the base or plane that contains the base.
Hexagon (wolfram)	Is a six-sided polygon.
Histogram	A bar graph that shows how many data values fall into a certain interval. The number of data items in an interval is a frequency. The width of the bar represents the interval, while the height indicates the number of data items, or frequency, in that interval.
Instantaneous Rate of Change	The rate of change at a particular moment. For a function, the instantaneous rate of change at a point is the same as the slope of the tangent line at that point.
Integers	The numbers in the set {â€¦-4, -3, -2, -1, 0, 1, 2, 3, 4â€¦}.
Inverse variation	A relationship between two variables, x and y, that can be expressed as , where k is the constant of variation. When one variable increases the other decreases in proportion.
Length	A one-dimensional measure that is the measurable property of line segments.
Line	A collection of an infinite number of points in a straight pathway with unlimited length and having no width.
Linear function	A relationship between two variables such that for a fixed change in one variable, there is fixed change in the other variable. If there is one independent variable (e.g. f(x)=mx+b), then the graph of the function will be a line. If there are two independent variables (e.g. f(x,y)=ax+by+c) then the graph of the function will be a plane.
Mean	There are several statistical quantities called means, e.g., harmonic mean, arithmetic mean, and geometric mean. However, â€œmeanâ€• commonly refers to the arithmetic mean that is also called arithmetic average. Arithmetic mean is a mathematical representation of the typical value of a series of numbers, computed as the sum of all the numbers in the series divided by the count of all numbers in the series. Arithmetic mean is the balance point if the numbers are considered as weights on a beam.
Median	When the numbers are arranged from least to greatest, the

	middle number of a set of numbers, or the mean of two middle numbers when the set has two middle numbers is called median. Half of the numbers are above the median and half are below it.
Mode	The most frequent value(s) of a set of data. A data set may have more than one mode if two or more data values appear the most. When no data value occurs more than once in a data set, there is no mode.
Model	To represent a mathematical situation with manipulatives (objects), pictures, numbers or symbols.
Multiples	The numbers that result from multiplying a given whole number by the set of whole numbers.
Operation	Any mathematical process, such as addition, subtraction, multiplication, division, raising to a power, or finding the square root.
Ordered pair	The location of a single point on a rectangular coordinate system where the first and second values represent the position relative to the x-axis and y-axis, respectively.
Outcome	A possible result of an experiment.
Pattern	A predictable or prescribed sequence of numbers, objects, etc. Patterns and relationships may be described or presented using multiple representations such as manipulatives, tables, graphics (pictures or drawings), or algebraic rules (functions).
Percent	Per hundred; a special ratio in which the denominator is always 100. The language of percent may change depending on the context. The most common use is in part-whole contexts, for example, where a subset is 40 percent of another set. A second use is change contexts, for example, a set increases or decreases in size by 40 percent to become 140% or 60% of its original size. A third use involves comparing two sets, for example set A is 40% of the size of set B, in other words, set B is 250 percent of set A.
Perimeter	The distance around a two dimensional figure.
Plot	To locate a point by means of coordinates, or a curve by plotted points, or to represent an equation by means of a curve so constructed.
Point	A specific location in space that has no discernable length or width.
Prism	A polyhedron that has two congruent and parallel faces joined by faces that are parallelograms.
Probability	A measure of the likelihood that a given event will occur;

	expressed as a ratio of one event occurring (favorable outcomes) to the number of equally likely possible outcomes (sample space). Probability is expressed on a linear scale from 0 (impossibility) to 1 (certainty), also expressed as a percentage between 0 and 100%. Experimental probability of an event A is the ratio of the number of times the event A occurs to the total number of trials or times the activity is performed. Theoretical probability of an event A is the ratio of the number of outcomes in event A to the number of outcomes in the sample space.
Proportion	A mathematical sentence stating that two ratios are equal.
Proportional	Having the same or a constant ratio. Two quantities that have the same ratio are considered directly proportional. Two quantities whose products are always the same are considered inversely proportional.
Pyramid	A three-dimensional figure whose base is a polygon and whose faces are triangles with a common vertex.
Quadrant	Any polygon with four sides, including parallelogram, rhombus, rectangle, square, trapezoid, kite.
Rate	A ratio that compares two quantities of different units.
Real number	The set of all rational and irrational numbers.
Real-world problem	A problem that is an application of a mathematical concept in a real-life situation.
Rectangle	A parallelogram with four right angles.
Reflection	A transformation that produces the mirror image of a geometric figure over a line of reflection, also called a flip.
Relation	A relation from A to B is any subset of the cross product (Cartesian product) of A and B.
Root	A root of a polynomial is a number x such that P(x)=0. A polynomial of degree n has n complex roots.
Rotation	A transformation of a figure by turning it about a center point or axis. The amount of rotation is usually expressed in the number of degrees (e.g., a 90Â° rotation). Also called a turn.
Scale	The numeric values, set at fixed intervals, assigned to the axes of a graph.
Set	A set is a finite or infinite collection of distinct objects in which order has no significance.
Side	The edge of a polygon (e.g., a triangle has three sides), the face of a polyhedron, or one of the rays that make up an angle.
Similar figures	Figures that are the same shape, have corresponding,

	congruent angle's and have corresponding sides that are proportional in length.
Simplify	The process of converting a fraction or mixed number, to an equivalent fraction, or mixed number, in which the greatest common factor of the numerator and the denominator of the fraction is one. Simplify also refers to using the rules of arithmetic and algebra to rewrite an expression as simply as possible.
Square	A rectangle with four congruent sides; also, a rhombus with four right angles.
Sum	The result of adding numbers or expressions together.
Table	A data display that organizes information about a topic into categories using rows and columns.
Theorem	A statement or conjecture that can be proven to be true based on postulates, definitions, or other proven theorems. The process of showing a theorem to be correct is called a proof.
Transformation	An operation on a figure by which another image is created. Common transformations include reflections (flips), translations (slides), rotations (turns) and dilations.
Transversal	A line that intersects two or more lines at different points.
Triangle	A polygon with three sides.
Unit	A determinate quantity (as of length, time, heat, or value) adopted as a standard of measurement.
Variable	Any symbol, usually a letter, which could represent a number. A variable might vary as in f(x)=2x+1, or a variable might be fixed as in 2x+1=5.
Circle	A closed plane figure with all points of the figure the same distance from the center. The equation for a circle with center (h, k) and radius r is: $(x - h)^2 + (y - k)^2 = r^2$
Exponent (exponential form)	The number of times the base occurs as a factor, for example 2^3 is the exponential form of 2 x 2 x 2. The number two (2) is called the base, and the number three (3) is called the base, and the number three (3) is called the exponent.
Fraction	A rational number expressed in the form $^a/_b$, where a is called the numerator and b is called the denominator. A fraction may mean part of a whole, ratio of two quantities, or may imply division.
Function	A relation in which each value of *x* is paired with a unique value of *y*. More formally, a function from A to B is a relation *f* such that every *a*Â $\in$ *A* is uniquely associated with an

	object *F*(*a*)Â $\in$ *B*.
Inequality	A sentence that states one expression is greater than (>), greater than or equal to (≥), less than (<), less than or equal to (≤), another expression.
Pi	The symbol designating the ratio of the circumference of a circle to its diameter. It is an irrational number with common approximations of either 3.14 of 22/7.
Radical	The symbol $\sqrt[n]{x}$Â used to indicate a root. The expressionÂ $\sqrt[n]{x}$Â is therefore read â€œx radical nâ€ • or "the nth root of x." A radical without an index number is understood to be a square root.
Ratio	The comparison of two quantities, the ratio of a and b is a:b or a to b or a/b, where $b \neq 0$.
Rational Number	A number that can be expressed as a ratio a/b, where a and b are integers and $b \neq 0$.
Scientific Notation	A shorthand method of writing very large or very small numbers using exponents in which a number is expressed as the product of a integer power of 10 and a number that is greater than or equal to one (1) and less that 10(e.g., 7.59.x 10^5 = 759,000).
Slope	The ratio of change in the vertical axis (y-axis) to each unit change in the horizontal axis (x-axis) in the form rise/run or ?y/?x. Also the constant, *m*, in the linear equation for the slope-intercept form $y = mx + b$, where $m = \frac{y_1 - y_2}{x_1 - x_2}$
Vertex	The point common to the two rays that form an angle; the point common to any two sides of a polygon; the point common to three or more edges of a polyhedron.
Volume	The amount of space occupied in three dimensions and expressed in cubic units.
Weight	Measures that represent the force of gravity on an object; mass of an object remains the same regardless of its location; weight of an object changes depending on the gravitational pull at its location.
Width	The shorter length of a two-dimensional figure. The width of a box is the horizontal distance from side to side (usually defined to be greater than the depth, the horizontal distance from front to back).

y-axis	The vertical number line on a rectangular coordinate system

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