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Mario Math with Millennials:
The Impact of Playing the Nintendo DS on Student Achievement

A Dissertation

Presented to

The Morgridge College of Education

University of Denver

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

by

Adam Gelman

June 2010

Advisor: Kent Seidel

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Title: Mario Math with Millennials: The Impact of Playing the Nintendo DS on Student Achievement

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ABSTRACT

One of the biggest innovations of the last century has been the invention of the video game. Video games are an extremely popular form of entertainment today. While some question the use of video games in education, others argue that video games are one innovation that if introduced into the classroom, might change how teachers effectively engage learners. This quantitative study examined the impact of *Brain Age 2* for the Nintendo DS on seventh grade achievement in math and on student attitude towards school. A sample of eighty seventh graders from the same school played the Nintendo DS daily for fifteen minutes over nine weeks. No significant difference was found in math achievement after using the game. Achievement in mathematics was analyzed with a paired t-test. Student attitude was measured using a survey and analyzed using nonparametric statistics. On the survey, students who played the Nintendo DS daily reported a more positive attitude towards their teachers, classes, and school than those that did not play the Nintendo DS.

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CHAPTER I: INTRODUCTION

On January 8, 2002 George W. Bush signed into law *The No Child Left Behind Act* (NCLB). This educational reform increased the federal government's role in education. Its goal is to improve the performance in elementary and secondary education through higher standards and accountability. Under NCLB, every student must master mathematics and language arts standards by receiving a proficient score on state assessments by 2014 (US Department of Education, 2003a). Schools are held accountable for how well students perform on state assessments, so they are under pressure to increase student achievement. For that to happen, students must be engaged and productive while in the classroom. According to the US Department of Education (2004), "America's schools are not producing the math excellence required for global economic leadership and homeland security in the 21st century," and poor math performance in schools negatively impacts a students' future. More research is needed on instructional methods that help student learn in math.

An essential component of facilitating learning is understanding learners. Who are the students sitting before us in our classrooms and how do they learn? The learners in front of us today in our schools are different than any previous generation that has come before it. Howe and Strauss labeled the students in our classrooms today millennials; they represent the first generation that has spent their entire lives surrounded by interactive information technology (Howe and Strauss 2000, 2003). They were born

between the years of 1982 and 2001. To millennials, technology has been around all their lives so it's not novel to them; it's a part of life. Millennials have grown up surrounded by technological innovations such as cell phones, MP3 players, digital cameras, and video games.

One of the biggest innovations of the last century has been the invention of the video game. Video games are an extremely popular form of entertainment today. It is estimated that by the time a US student graduates from college he will have played 10,000 hours of video games (Prensky, 2001, p. 1). The 9.5 billion US dollar a year video game industry is proof that video games are popular with kids and adults, and video games are not just for males as one might suspect. A recent survey by the Entertainment Software Association (ESA) found that 60% of all game players were men, and 40% were women (ESA, 2006). One survey found that 97% of teens play computer, web, portable, or console games. The survey also found that 72% of teens play puzzle games, 59% play strategy games, and 49% play simulation games. Unfortunately, Green and McNeese report that "while students and adults enjoy playing games, they are seldom used in an educational setting to enhance learning outcomes" (Green & McNeese, 2007, p. 14).

Many educators and parents oppose video games being part of the curriculum in school (Virvou, Katsionis, and Manos, 2005). While some question the use of video games in education, others argue that video games are one innovation that if introduced into the classroom, might change how teachers effectively engage learners (Squire & Jenkins, 2003). Leaders in the area of video games and education believe video games

can provide a positive experience for students that make them better problem solvers (Shaffer, Squire, Halverson, & Gee, 2004). One study found that more innovative approaches to teaching are more effective than traditional instruction. Students taught through a multisensory approach performed better on achievement tests and indicated more positive attitudes (Farkas, 1997).

Using forms of entertainment in the classroom is not a new practice. Television and movies, once considered innovative, are now common in classrooms (Shaffer, Squire, Halverson, & Gee, 2004). If schools want to raise student achievement, they must realize that today's learners are different, and they must teach them using the tools that they use to learn; not the tools that the teacher used to learn.

The Nintendo DS is the latest handheld gaming device released in 2004, and updated with a slimmer design, the DS lite, in 2006. The DS flips open with screens at the top and bottom and speakers on the side. The top and bottom screens are LCD or touch-sensitive. The DS also contains buttons typical of other handheld gaming devices on the sides. Other features include a built-in microphone and the ability to connect to the Internet so multiple players can compete against and collaborate with one another.



Figure 1: The Nintendo DS

Games come on small game cards. Over 500 games are available in the United States, and over 700 are available in Japan (Nintendo Co., Ltd., 2008). In March of 2010, the general manager of Nintendo Shigeru Miyamoto announced his next major project involves establishing the Nintendo DS as a learning tool in schools (Molina, B., 2010).

The video game used in this study is *Brain Age 2* based on Dr. Ryuta Kawashima's brain research in Japan. The game was released in the United States in August of 2007. This edutainment video game offers the player several minigames (a short, simplistic videogame) to play. In the game, players have three options: Quick play, Daily Training, or Sudoku. In quick play and daily training, any of the minigames can be played, but no score is given in quick play. In the Sudoku mode, players can solve one of a hundred puzzles. The Nintendo DS keeps track of the player's progress and gives a stamp for completing minigames. Different features are unlocked the more stamps that are collected. The idea behind the game is that the brain needs exercise to keep it active and alive, and that's what the minigames offer.

This researcher believes that video games should not be ignored as an instructional tool by teachers, but viewed as a method that can be used to enhance instruction. Video games are an integral part of society yet rarely used in the classroom for instruction. It is important that studies be conducted to determine what impact these video games have on student achievement. If this data were known, the information could lead to possible strategies that could help teachers integrate computer and video games into their instructional practices.

Statement of the Problem

Today's information or digital technology offers students all kinds of new, highly effective tools they can use to learn on their own – from the Internet with almost all the information, to search and research tools, to analysis tools, to social tools that allow students to network and collaborate with people around the world. Today's students spend a large portion of their time using many forms of technology that are not currently or traditionally found in classrooms called “alternative technologies” such as the Nintendo DS, cell phones, iPods, Nintendo Wii, the LeapFrog learning systems, Guitar Hero, D.D.R. system (Dance Dance Revolution). Some of these alternative technologies show a great deal of potential as teaching and learning tools in the twenty-first century K-12 classrooms. Today's students at all levels are highly motivated and deeply engaged when they use such technologies, and in the future, students will continue to acquire and master these technologies whether or not they are in schools. How many of these tools are currently available in our schools for our students to use? Not many. Teachers often feel these tools are just “fun” and learning cannot (or should not) be fun. Most schools ban these tools instead of teaching with them, showing students how to use them, and more importantly showing students how they can learn from them.

This study contributes to the body of knowledge needed to address this problem by exploring student attitudes toward learning and their school when video games and alternative technologies are part of the curriculum and the impact these tools have on student achievement. The Nintendo DS is the alternative technology used in this study.

The Nintendo DS game system is one example of a handheld gaming system with powerful built-in capabilities to engage students in their learning.

Significance of the Study

Not a lot of research has been done on the Nintendo DS and its impact on student achievement. What is not known is if *Brain Age 2* would help raise student achievement in middle schools in the United States. There is a need to research this with a group of students in the United States to add to the existing body of knowledge. While a large body of evidence exists for the skills acquired while playing video games, very little research exists on the direct impact video games have on student achievement. That is an area that researchers need to find out more about if schools are going to start integrating video games into the classroom.

The purpose of this study was to determine how use of the Nintendo DS, one alternative technology, impacts student learning behaviors and academic performance. The question dealt with in this study is whether the Nintendo DS has any impact on student achievement when played on a daily basis. This study will provide meaningful data about the power of alternative technologies in the classroom.

Research Questions

1. What impact does playing *Brain Age 2* on a Nintendo DS have on student achievement in a math class?
2. What are students' (a) attitude toward classes and teachers, (b) attitude toward school (c) goal valuation (d) motivation and self-regulation, and (e) academic self perceptions?

Definition of Terms

Alternative Technology: Technology not traditionally found in the classroom (iPod, Nintendo Ds, etc.)

Dr Kawashima's Brain Age 2: A video game created by Nintendo for the Nintendo DS. Brain Training features activities designed to help stimulate your brain and give it a workout. There are several games within the game itself.

Edutainment: "Entertainment that is designed to be educational" (Shaik, 2005, p. 3).

Engagement: Engagement in school is students being invested through attending, participating, and putting forth effort to learn because they feel a sense of belonging and have support from their teachers, peers, and adults (Glanville & Wildhagen, 2007; Green, Miller, Crowson, Duke & Akey 2004; Klem & Connell, 2004; National Center for School Engagement, 2006b; Woolley & Bowen, 2007).

Instructional technology: Technology in service to learning (Oblinger, 2005).

Measure of Academic Progress (MAP): The MAP test is a computer-adaptive assessment that will increase or decrease its difficulty level based on students' answers to previous questions (NWEA, 2004-2006).

Minigame: A short, simplistic video game often contained in another videogame

Nintendo DS: A handheld games console created by Nintendo in 2004. Features include WiFi, microphone and touch screen.

Video Game: The terms computer game, digital game, and video game can be used interchangeably. Video games is a term used to describe games played on a digital system such as a computer or console where "players engage in an artificial conflict,

defined by rules, that results in a quantifiable outcome” (Salen & Zimmerman, 2003, p. 96).

Organization of the Study

The study is organized into five chapters. Chapter 1 contains the introduction, statement of the problem, research questions, significance of the study, definition of terms, and limitations of the study. A review of selected literature related to student engagement, millennials, math instruction, and video games can be found in Chapter 2. Chapter 3 presents the methodology that will be used to gather the data for the study. Chapter 4 discusses the results of the data collection and answers the research questions. The summary, conclusions based on the findings, discussion, and recommendations for further study are discussed in Chapter 5.

CHAPTER II: REVIEW OF THE LITERATURE

Theoretical Framework: Engagement

In order for students to be successful in school, they must be engaged. (Appleton et al., 2006). Engagement in school is students being invested through attending, participating, and putting forth effort to learn because they feel a sense of belonging and have support from their teachers, peers, and adults (Glanville & Wildhagen, 2007; Green, Miller, Crowson, Duke & Akey 2004; Klem & Connell, 2004; National Center for School Engagement, 2006b; Woolley & Bowen, 2007). Four types of engagement have been defined in the literature: academic (time on task/time engaged in classes), behavioral (attendance/number of referrals), cognitive (valuing learning/seeing relevance of the work being done/processing information), and psychological (how students connect to the school) (Appleton et al., 2006; Lehr et al., 2004).

The relationship between student engagement and student achievement has been studied for a long time. In the 1920s, John Dewey began studying why students were bored and disengaged in schools. Dewey believed that teachers should create learning environments that were relevant and meaningful to students and that schools needed to change to meet the needs of individual students (Dewey, 1938). In 2004, the National Research Center and Institute of Medicine said, “For Dewey, building an engaging school community is not just a strategy to improve outcomes; it is essential to education itself” (2004, p. 17). Research has shown that students who are engaged in school regularly

attend and perform better (Alliance for Excellence in Education, 2007). Strong, Silver, and Robinson (1995) created SCORE, an acronym that describes the expectations that need to be met if students are going to be engaged. The needs are “Success (the need for mastery), Curiosity (the need for understanding), Originality (the need for self-expression), Relationships (the need for involvement with others), and Energy (what is necessary for a ‘complete and productive life’—to drive toward completion”) (p. 1).

Mihaly Csikzentmihalyi’s flow theory said that student engagement is highest when a combination of concentration, interest, and enjoyment were present and happening simultaneously in the learning environment. Frustration, boredom, and stress negatively impacted engagement. This theory is called the flow theory because it talks about when students are in the flow or engaged. The theory says that students are engaged when:

1. They are completely involved and focused.
2. They have a sense of joy-of being outside everyday reality.
3. They know what needs to be done and how well they’re doing as they progress.
4. They are capable of doing the activity.
5. They don’t know time is passing (Shernoff et al., 2003).

An emotional connection to the content being covered is also necessary if students are going to be engaged. The brain pays attention when there is an emotional connection. Emotion is what makes people pay attention, and when they’re paying attention learning is taking place (Wolfe, 2001). Strategies that can be used during instruction in the classroom to create that emotional connection are:

- Engaging prior knowledge (National Research Council, 2000)
- Engaging the senses (Kovalik & Olsen, 2001)
- Innovation (Kovalik & Olsen, 2001)
- Movement and Music (Kovalik & Olsen, 2001)
- Intensity of color and sound (Wolfe, 1998)
- Hands-on experiences (Kovalik & Olsen, 2001)
- Simulations (Wolfe, 2001)
- Role Playing (Wolfe, 2001)

Studies have shown that low student achievement is not usually the result of low ability but a result of “low student interest in the content and value of what is being taught” (McLaughlin & Blank, 2004, p. 1). When the curriculum is connected to the world in which students live, student engagement goes up. If students perceive the material as relevant to their lives, student engagement goes up. Effectively addressing student engagement in the classroom improves the chances of student success (Ferguson, 2002).

Millennials

Engaging the generation of students in our classrooms today is quite different than engaging students from previous generations. Generations are given a specific name referring to distinguishing characteristics of that generation. Howe and Strauss defined a generation as “a cohort group whose length approximates the span of a phase of life and whose boundaries are fixed by peer personality” (2000, p. 60). Many names have been given to the generation of students in schools today: Digital Gen, Net Gen, Generation

2000, Generation Next, Generation.com, Echo Boom, Boomer Babies, Generation X, Generation Y, and Generation “Why” (Howe & Strauss, 2000a). The name that is most common in the research and literature though is “Millennials” (Howe & Strauss, 2000a). The millennial generation was born between 1982 and 2001, and includes today’s children, teens, and youngest adults (*The Millennials*, 2004). In the United States, there are over 80 million Millennials. Jean Twenge, who identifies this generation as “Generation Me” believes those born in the late 1970s should also be included (Eubanks, 2006).

Millennials are said to be unlike any previous generation before them. This generation is more affluent, better educated, more ethnically diverse, and larger than any other generation. According to Wolburg and Pokrywczynski (2001), the Net Generation is: “idealistic, socially conscious, individualistic, anti-corporate, speak their minds, and dress as they please” (p. 33). Marc Prensky (2001) identifies the following as ten differences between Millennials and previous generations:

1. Twitch speed vs. conventional speed
Millennials process information quicker and faster than previous generations.
2. Parallel processing vs. linear processing
Millennials are comfortable doing more than one task at time such as watching TV and doing homework.
3. Graphics first vs. text first
Millennials prefer images before text while previous generations prefer the reverse. Since birth, millennials have been exposed to primarily images through television, movies, and video games, so they expect text to clarify the image while previous generations preferred the reverse.

4. Random access vs. step-by-step
The Internet has allowed Millennials to “click around” and not rely on only one source for information. Millennials think, “Why read something from beginning to end, or follow someone else’s logic, when I can just ‘explore the links’ and create my own?”
5. Connected vs. standalone
Millennials are used to asynchronous communication with all their tools (e-mail text messaging, chat rooms, Internet searches). Previous generations prefer synchronous communication (both people have to be there).
6. Active vs. passive
Millennials rarely read an instruction manual. They use trial and error to figure something out. Previous generations prefer reading the manual before even attempting a task.
7. Play vs. work
Play is work to millennials. They spend more on video games than movies, and computers are now used for entertainment software more than any other application. Logic, puzzles and higher-thinking is all involved in the games they play.
8. Payoff vs. patience
Millennials expect a reward for the work they do. Through all the video games they play, there is always a reward at the end. They move to the next level, they pass the game, or they get on the high-score list.
9. Technology-as-friend vs. technology-as-foe
Millennials embrace technology while previous generations often fear it, tolerate it, or use it meet their needs.

Howe and Strauss have identified specific traits of the Millennial persona (persona being a profile of a generation which most can relate to). The seven traits are special, sheltered, confident, team-oriented, conventional, pressured, and achieving.

Below is a description of each trait:

Special: Millennials were wanted and planned by their parents and are touted as special by their parents, community, and the media.

Sheltered: Millennials grew up in a time where society tried to keep youth safe through AMBER Alerts and strict curfews.

Confident: Millennials have a great relationship with their parents and the nation.

Team-oriented: Millennials prefer collaborating with others and use technology to organize activities with groups.

Conventional: They define their goals in terms of career and work-life balance. This generation tends to like and get along with their parents.

Pressured: Their day is filled with activities, and they feel the pressure.

Achieving: They have grown up with standards in education and embrace educational challenges (Howe & Strauss, 2003).

The most distinguishable characteristic of millennials is they have lived their entire lives surrounded by technology and “using computers video games, digital music players, video cams, cell phones, and all the other toys and tools of the digital age” (Prensky, 2001a, p. 1). Millennials are so immersed in technology, they do not even think of it as technology (Frاند, 2000). Millennials embrace technology and may question traditional practice in the classroom because they know the Internet can be used to look up ideas and concepts (Lyons, McIntosh, & Kysilka, 2003). Some consider today’s students “the most demanding and challenging students in history” (Tapscott, 1998). In the classroom, millennials do not want lectures, multiple-choice quizzes, or memorizing long lists. They want collaborative assignments, interactive lectures, technology, and varied software in the learning environment (Moore, 2005). Teachers must take into consideration the learning needs of this generation. According to Costello, Lenholt, and Stryker (2004), lecture is the most ineffective instructional technique for

Millennials. Tapscott (1998) identifies learning styles of Millennials that educators can use to help them plan lessons. The learning styles include:

1. Active Learners. Millennials prefer discovering information rather than being told information.
2. Communicative Learners. Millennials communicate through text messaging, e-mail, and social networking sites.
3. Creative Learners. Millennials are willing to try new methods and are open to new ideas. They are unafraid of figuring out things for themselves “without consulting manuals” and they prefer working in groups, and multitasking” (Lippincott, 2005, p.2).
4. Impatient Learners. Millennials want immediate feedback to their questions and answers.

When technology is utilized in classrooms, it “does away with the passivity associated with the traditional learning model in which the student is viewed as an empty vessel to be filled by the knowledge and expertise of the teacher” (p. 144). Knowing what the literature says about how millennials learn can help guide the instruction that takes place in the classroom so their learning needs are met.

Math Instruction in the United States

“Math wars” is the term used to describe the debate that goes on regarding the best approach to teaching math. The two approaches to teaching mathematics that exist in the United States today are the constructivist approach and the skills approach. The constructivist approach is based on the belief that students should be taught how to think

through problems with an understanding of why the answer is correct. Just knowing the answer is not enough, and drilling basic facts and formulas is generally not part of the curriculum.

The middle school being studied uses a constructivist approach to teaching math with the *Connected Math Project (CMP)*, a complete mathematics curriculum for grades 6, 7, and 8. The National Science Foundation funded the curriculum that was developed and field tested between 1991-1997 and 2000-2006. The philosophy of the program is that all students should be able to reason and communicate proficiently in mathematics. The design of the curriculum is meant to help students in mathematics with the use of vocabulary, the development of content knowledge, and the ability to define and solve problems using different tools and techniques. This curriculum also emphasizes the use of technology and named technology as one of the five fundamental mathematical and instructional themes used to guide the development of the curriculum in addition to mathematical investigations, connections, teaching for understanding, and reasoning. There are twenty-four units in the curriculum, eight units for each grade level. Each unit contains four to seven investigations for students to explore in class. Each investigation includes a section called Applications, Connections, and Extensions (ACE) that contains problem sets with questions that allow students time to practice, apply, and connect their knowledge to previously learned material. The end of each unit contains a reflection section where students articulate their understanding of the skills in that unit in a written format. With this curriculum, teachers are trained in leading students and offering suggestions without just giving them the solution or the method to solve the problem

<http://www.math.msu.edu/cmp>). The goal of this approach is to connect math to students' lives through the problems that they solve. This is referred to as "fuzzy math" by those that believe in the skills approach where students work on exercises and drills to master concepts (Borusk, 2003).

The constructivist method does attempt to make a connection between math and students' lives, but as Borusk (2003) says, "Too many children are reaching upper grades without fundamental math skills, thanks to a curriculum that is too un-challenging, too much oriented toward making math likable or fun, and way too low on classic skills." On the other hand, the skills approach does not relate to students' lives, and it does not motivate students to want to take more math classes (Middleton & Spanias, 1999).

Which method of teaching math is more engaging for students and helpful in raising achievement? Neither. While there have been increases in student achievement since 1990, the 2007 National Assessment of Educational Progress (NAEP) report card, only 32% of students were proficient or advanced in math compared to 30% in 2005 and 29% in 2003. In Colorado where this study is taking place, 38% were proficient or advanced (NAEP, 2007). In the 2007 Trends in International Mathematics and Science Study (TIMSS), eighth graders in the United States scored lower than 10 of the 36 countries that participated. This report also noted that achievement was highest among those students reporting using a computer at home and at school and lowest among students who do not use a computer at all or only use it at places other than home or school. In addition to students not achieving highly in mathematics, students have a negative perception of math, one that prevents them from learning (Townsend & Wilton,

2003; Wilkins & Ma, 2003). That attitude gets worse the longer students are in school because they question the relevance of math to the real world (Wilkins & Ma, 2003; Lewkowicz, 2003). Research indicates that when students go from elementary school to middle school, their enjoyment of mathematics decreases significantly (Lewkowicz, 2003; Middleton & Spanias, 1999). The TIMSS report found that students with a positive attitude had higher average math achievement than those with negative attitudes.

Innovation

If neither the constructivist nor skills approach is effective in engaging students and helping them achieve at high levels, an innovation that supplements a school's curriculum might help. Innovation is the introduction of something new, a new idea, method, or device (Merriam-Webster Online, n.d.). Innovation that occurs in a school has the potential to raise student achievement. John Hattie describes innovation as always trying to improve the quality of learning taking place (Hattie, 1992, p. 7). Innovation results in enthusiastic teachers and motivated students who are experiencing something new and different (Hattie, 1992, p. 8). In order for innovation to take place in education, the following points should be considered:

1. Innovation is a state of mind and both students and teachers must be able to dream, imagine, and create.
2. Innovation requires deep engagement and persistence.
3. Innovation involves action.
4. Innovation is a social phenomenon, often reflecting the ideas of a group or individuals.

5. Innovation involves risk-taking (Ballantyne, McLean, and Macpherson, 2003)

One study found that more innovative approaches to teaching are more effective than traditional instruction. Students taught through a multisensory approach performed better on achievement tests and indicated more positive attitudes (Farkas, 1997). In another study, traditional and non-traditional techniques were studied in a statistics course. The group receiving non-traditional teaching methods (active learning, mastery learning, problem based learning, and peer tutoring) scored 10% higher on exams (Horswill, 2002). Innovation is necessary to improve schools, but too often does not occur. The innovation in this study is introducing video games, specifically *Brain Age* and the Nintendo DS, into the classroom to supplement instruction. It is the goal of this study to measure how the innovation of using video games as an instructional tool impacts student achievement.

Video Games as Instructional Tools

Video games are used as an instructional tool in many settings. Businesses and the military use video games for training their employees (Prensky, 2001). Video games are a practical approach to training and recruiting employees, especially when the job requires a unique set of skills (Prensky; Nelson, 2006). Canon U.S.A. uses a video game to train copier technicians. The technician must place the parts of the copier in the right spot. Union Pacific designed a video game to teach employees how to safely drive cars and locomotives. In 2008, Hilton Garden Inn created the first video game for the hotel industry. In the game, employees are in a virtual hotel where they respond to typical requests from virtual guests.

Video games have been used for training in the military since the 1980s. Atari helped develop the video game *BattleZone* for gun training (Beck & Wade, 2006). Microsoft's *Flight Simulator* is used by the Air Force as an introduction to flight training (Howard, 2006). In 2002, the Army launched a video game for recruiting called *America's Army* (AA). The game has won multiple awards and is ranked as one of the top ten video games in the world (Howard, 2006). Since its first release, 26 versions have come out. In the game, the player acts like a soldier and must perform training and demonstrate competence before participating in combat. The medical training the game provides has been credited with saving two lives (Mezoff, 2008). The video game *Ambush* was designed to train soldiers what to do during an ambush. Soldiers can also create their own scenarios in the game (Laurennet, 2007).

In addition to the military and business, video games are also present in politics and the health care industry (Quirk, 2006). Carnegie Mellon created a video game called *PeaceMaker* that simulates the Israeli and Palestinian conflict. In *Food Force*, a game published by the United Nations World Food Programme, players try to help a famine-affected country recover (Schollmeyer, 2006). *Darfur is Dying* is a game about the crisis in Darfur. Video games are appearing as an instructional tool in a wide variety of industries. The healthcare industry has used video games to provide patients with information. *Re-Mission*TM was designed by Hopelabs to provide information to young patients with cancer. In the game, the player controls a robot as it travels through the human body killing cancer cells. One study showed that those who played the game became more knowledgeable about cancer (Beale, Kato, Marin-Bowling, Guthrie, &

Cole, 2007). In the video game *The Anatomy of Care*, players become a worker in a hospital and make decisions. The game shows the player the impact of those decisions on patient care and the perception of care for patients and family members (Will Interactive, 2008).

Video Games in Education

Video games are being studied as an instructional tool in a variety of industries, including education. When reviewing literature, Mitchell and Saville-Smith (2004) found computer games help to teach basic skills, to engage learners, to build social skills, and to aid in the acquisition of complex skills. McFarlane, Sparrowhaw, and Heald (2002) studied the knowledge gained using videogames in primary and secondary teaching based on teachers' opinions. Teachers had a positive view of videogames in the study, but they didn't feel they would have the time to use the videogame and cover all the content in their curriculum. In Chile, the Nintendo Gameboy was introduced into disadvantaged classrooms. Researchers found that student motivation and interest were raised when video games were added into the curriculum, and teachers accepted the video games too after seeing the reaction of their students (Rosas et al., 2003).

In the geography-based game VR-ENGAGE, players travel through a virtual world collecting missing pages from a book and answering questions as they go. In their study, Virvou, Katsionis, and Manos (2005) found that games can be motivating and increase the learning effectiveness of students. In another game called Outbreak, players must figure out the cause of an outbreak within a certain amount of time. In a survey of

students, positive responses were given three times more often than negative responses (Clark & Smith, 2004).

A huge gap exists in the literature on video games and education. Most of the research, especially in the United States, focuses on content (what is happening in the game), skills acquired by the player, and the attitude of the player, but little research exists about the direct impact of video games on student achievement. In Scotland, LTS (Learning and Teaching Scotland), the organization that develops curriculum, is beginning to study how video games impact achievement. In one of the only studies conducted on the Nintendo DS, researchers found that sixth grade students who played *Brain Age 2* on the Nintendo DS at the start of their class for 20 minutes improved on their test scores 50% more than those that did not. The treatment group in this study also had higher attendance and better behavior (Irvine, 2008).

Summary

Millennials are a generation that plays to learn. Marc Prensky says since students have been surrounded by video games their whole lives, they expect to be equally engaged in the classroom (Prensky, 2001, p. 1). Today's video games are based on trial and error, and millennials see that "as a metaphor for learning" (Feiertag & Berge, 2008). Dr. Kurt Squire said the following about video games and engagement in an interview at the "Classrooms of the Future" Symposium:

I prefer to think about games as being engaging. Watch someone playing a game- particularly a hard one- and what they're doing may look more like work than fun. I also think that for many games, fun, or engagement is naturally a byproduct of learning.

Sometimes this is pattern matching, other times it is problem solving. As opposed to seeing them at odds, I argue that when games are fun, there is learning going on.

Learning things is inherently fun. Only in schools do we try to decouple the two (Landsberger, 2004, p. 4). Pairing fun and learning together might help improve student engagement and achievement in schools.

CHAPTER III: METHODOLOGY

Today's technology offers students all kinds of new, highly effective tools they can use to learn on their own – from the Internet with information, to search and research tools, to analysis tools, to creation tools to present projects in a variety of media, to social tools that allow students to network and collaborate with people around the world.

Today's students spend a large portion of their time using many forms of technology that are not currently or traditionally found in classrooms. Some of these alternative technologies show a great deal of potential as teaching and learning tools in the twenty-first century K-12 classrooms. This study evaluated the impact of playing *Brain Age 2* on math achievement in 7th grade math and student attitudes towards school and learning.

The two research questions are: (1) What impact does playing *Brain Age 2* on a Nintendo DS have on student achievement in a 7th grade math class, as measured by the MAP test? And (2) What are students' (a) attitude toward classes and teachers, (b) attitude toward school (c) goal valuation (d) motivation and self-regulation, and (e) academic self perceptions?

Chapter 3 describes the design of the study and the methodology used. Included in this section are descriptions of the population, instrumentation, the research questions, data analysis procedures, threats to validity, and feasibility.

Justification for Quasi-Experimental Design

In order to study the impact of playing Nintendo DS on student achievement, the quasi-experimental design was used. This study compared the achievement of two groups of seventh grade students; one that incorporated the game *Brain Age 2* and one that did not. This study took place at an urban middle school in Colorado. Eighty students from three different classes with the same teacher participated in the study. All three classes shared the same course title, they covered the same content, and they had the same age participants.

Table 1: Quasi-Experimental Design

| | A | B | C | D |
|---|---|---|---|---|
| 1 | R | O | X | O |
| 2 | R | O | | O |

- In the table above, Row 1 indicates the treatment group; row 2 indicates the control group. The two Rs refer to the groups being randomized.
- The Os in column B indicate the MAP test that was given at the beginning of the study.
- The X in column C indicates the Nintendo DS that was incorporated into one group but not the other.
- The Os in column D refers to the MAP test that was given to both groups at the end of the study.

Design

This quasi-experimental study examined how playing *Brain Age 2* on a daily basis affects achievement in a math classroom. The design of the study consisted of a

treatment/control group design. The treatment was the Nintendo DS. This study occurred during the second quarter of the 2009-2010 school year.

Population

The population consisted of 80 students from three seventh grade classes in an urban school district in Colorado. The school district where this study took place has 36,967 students, primarily Hispanic (50.6%) followed by White (24.1%), Black (20.1%), Asian (4.3%) and Native American (0.8%). In 2010, 63.4% of students qualify for free/reduced lunch, 38% of students are ELLs, and 89% are Spanish-speakers. Students come from over 120 countries and speak more than 95 languages. There are 55 schools in the district, and 23 of these are designated as Title 1 Schools.

The instructional model for math in the district studied consists of a daily block of at least 90 minutes for all students. The instruction is divided into sections called Launch, Explore, and Summarize. Each day begins with a number talk where a math problem is presented that helps students develop their fluency with a variety of number relationships. Every student works on the problem, and then students communicate their thinking and share with the class different strategies for solving the problem. The Launch section of instruction is teacher-directed. During this time, the teacher introduces students to the big ideas for that day and helps students understand the problem setting and the mathematical context for the work they will be doing. During the Explore section of instruction, students work in groups to solve problems by talking, reading, thinking, and experimenting. The teacher walks around during this time and works with different groups to clarify their thinking and encourage students to extend their thinking and to

make connections to previously learned concepts. The final section of the ninety minutes (Summarize) is devoted to a summary where students reflect on the mathematical concepts learned. They share and present their ideas to the class. During the math block, all students are working on grade level content with the teacher providing differentiation where needed.

Table 2 shows how seventh grade students scored the last three years on the Colorado Student Assessment Program (CSAP) in the school and district where this study took place. The district does not give the MAP test to all students every year, so that data is not available. CSAP measures student performance each year in reading, writing, mathematics, and science relative to the Colorado State standards that set what students should know at particular points in their education (CDE, 2008).

Table 2: CSAP Scores

| 7th Grade CSAP Results: Math | | | | | | | |
|------------------------------|------|------------------|------------------------|--------------|------------|------------|-------|
| | Year | % Unsatisfactory | % Partially Proficient | % Proficient | % Advanced | % No Score | Total |
| State Average | 2009 | 13.46% | 31.69% | 30.59% | 23.62% | 0.63% | 57757 |
| | 2008 | 18.29% | 35.00% | 27.82% | 18.37% | 0.52% | 57175 |
| | 2007 | 14.29% | 34.69% | 29.54% | 20.94% | 0.54% | 57153 |
| District Average | 2009 | 21.98% | 40.11% | 25.54% | 11.48% | 0.89% | 2361 |
| | 2008 | 35.31% | 37.09% | 18.28% | 8.38% | 0.94% | 2243 |
| | 2007 | 23.73% | 43.64% | 22.74% | 9.04% | 0.86% | 2335 |
| School Average | 2009 | 32.57% | 43.09% | 19.74% | 3.29% | 1.32% | 304 |
| | 2008 | 43.49% | 35.96% | 15.07% | 4.11% | 1.37% | 292 |
| | 2007 | 23.20% | 48.37% | 22.88% | 5.23% | 0.33% | 306 |

The population for this study ranged in age from 12-13. The students involved in this study were from one of three sections of a course called “Math 7.” Students were in the class 96 minutes every day. All three sections were taught by the same teacher and

covered the same content. Each section had approximately 35 students. In addition to the 96 minutes of daily instruction, 40 students were placed in an elective class called “Technology 7” where they played the Nintendo DS daily for 15 minutes. The class was 46 minutes in length. The school’s technology curriculum was taught during the other 31 minutes. The Nintendo DS was integrated with the instruction presented in class. Students’ prior experience with the Nintendo DS was not a variable controlled in this study, and it can be assumed that students had varying degrees of prior exposure to the Nintendo DS.

Assignment of participants to the “technology” course was random. The names of students in Math 7 were placed in a box. The first 40 names drawn were placed in the technology elective, and the next 40 names were placed in the control group. The principal signed a consent form giving the researcher permission to conduct the study. Parents of the 40 participants in the technology elective signed a consent form (Appendix D) giving their students permission to take part in the study. Once in the class, students were required to sign an assent form (Appendix C) to participate in the study. Every student had the option to not participate in the study. Every student chose to participate in the study. Names that compromise confidentiality have been changed on consent forms and other documents.

Convenience

This population was, in part, a convenience population. While the population was reflective of many, urban settings and students, this study site was practical in terms of resources needed. Time, money, access to students and a site were available. Students

played the Nintendo DS during a 9-week elective class during the 2nd quarter of the school year. This way, no instructional time was lost during the math period. Costs were manageable; Nintendo DS systems and copies of the game *Brain Age 2* were purchased by the researcher for the study. The research site and the study were approved by the school's principal (Appendix E).

Informed Consent and Ethical Considerations

Consent forms were provided to students and their parents/guardians in both English and Spanish. Permission to conduct research was requested from the Internal Review Board before beginning any research. Only the researcher and the researcher's advisor at the University of Denver had access to data collected. The welfare and protection of the students was a primary concern of the researcher at all times.

The Role of the Researcher

The researcher taught the "Technology" elective class. The researcher did not do any teaching or discussing of math during this class. The researcher's role was to supervise students during this class as they played *Brain Age 2* and to teach the school's technology curriculum when students were not playing the Nintendo DS.

Research Questions

1. What impact does playing *Brain Age 2* on a Nintendo DS have on student achievement in a 7th grade math class, as measured by the MAP test?

H₀1: Playing *Brain Age 2* on Nintendo DS has no impact on student achievement in math.


H_A1: Playing *Brain Age 2* on Nintendo DS does have an impact in student achievement in math.





2. What are students' (a) attitude toward classes and teachers, (b) attitude toward school (c) goal valuation (d) motivation and self-regulation, and (e) academic self perceptions?

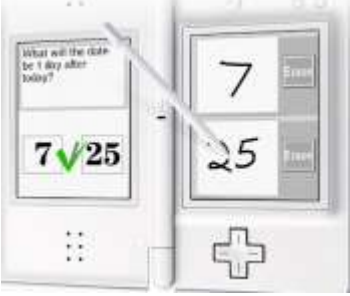

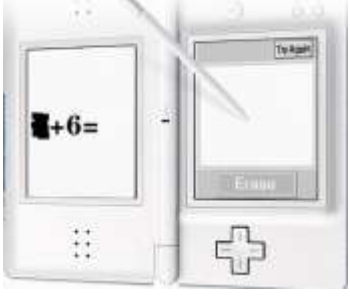
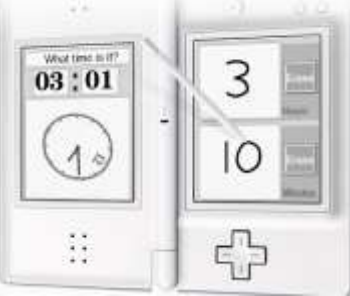
Brain Age 2


The video game used in this study is *Brain Age 2* based on Dr. Ryuta Kawashima's brain research in Japan. This edutainment video game offers the player several minigames (a short, simplistic videogame) to play. In the game, players have three options: Quick play, Daily Training, or Sudoku. In the Sudoku mode, players can solve one of a hundred puzzles. The Nintendo DS keeps track of the player's progress and gives a stamp for completing the Daily Training. Different features are unlocked the more stamps that are collected. The idea behind the game is that the brain needs exercise to keep it active and alive, and that's what the minigames offer. The game's Training mode includes the activities listed in Table 3 below (<http://www.brainage.com>):

Table 3: Brain Age Minigames description

| | | |
|-------------|--|---|
| Sign Finder | Solve each problem by entering one of the mathematical symbols (+, -, ×, ÷) on the Touch Screen. |  |
|-------------|--|---|

| | | |
|----------------------|--|---|
| <p>Piano Player</p> | <p>Use the piano keyboard displayed on the Touch Screen to play along with the musical score on the left.</p> |  |
| <p>Word Blend</p> | <p>Listen to the words being spoken and write down what you hear on the Touch Screen.</p> |  |
| <p>Word Scramble</p> | <p>Unscramble the spinning letters shown on the LCD screen and write the word you find on the Touch Screen.</p> |  |
| <p>Change Maker</p> | <p>Calculate the difference between the bill total and the amount tendered, then make correct change by tapping coins and bills on the Touch Screen.</p> |  |

| | | |
|-----------------------|--|---|
| <p>Calendar Count</p> | <p>Solve problems based on the current calendar day, then write the correct day or date on the Touch Screen.</p> |  |
| <p>Memory Sprint</p> | <p>Follow the progress of the shaded runner as he competes in a footrace, then write down the position in which he finished on the Touch Screen.</p> |  |
| <p>Math Recall</p> | <p>Memorize the number before it is blacked out, then solve the problem by writing the answer in the Touch Screen.</p> |  |
| <p>Clock Spin</p> | <p>Look at the clock on the LCD screen and write down the time on the Touch Screen.</p> |  |

| | | |
|--------------------|--|---|
| <p>Block Count</p> | <p>Watch the falling blocks and remember their positions in the shaded area. When all the blocks have fallen, write down the height of one column on the Touch Screen.</p> |  |
|--------------------|--|---|

Students played the game daily for fifteen minutes. In this study, students completed the daily training first each day. If they finished, they could play other minigames or solve a Sudoku puzzle. The game also contains a Brain Age Check that runs three random tests to determine the player’s Brain Age. Students did not do this because there was not time in the fifteen minutes to complete the Brain Age check and the daily training. Students were given the freedom to choose what minigames they played during the fifteen minutes.

Instrumentation

Research Question #1

The Northwest Evaluation Association’s (NWEA) Measures of Academic Progress (MAP) was used to measure student growth over the 9 weeks. Students took the test during the first and last weeks of the study. The MAP test is a computer-adaptive assessment that will increase or decrease its difficulty level based on students’ answers to previous questions, so the test is different each time a student takes it. The publisher recommends giving the test three times during the school year, and frequent testing is not recommended when measuring growth (NWEA, 2004-2006). Despite this

recommendation, the MAP test was used in this study to see if there was an impact large enough after 9 weeks of playing *Brain Age 2* that could be detected by the test.

The MAP test is aligned with state standards. According to Pelton and Pelton (2006),

(S)tarting with a large existing item bank of approximately 15,000 items and employing subject-matter experts, the NWEA has been able to identify useful collections of items that are (a) consistent with goals and theoretical underpinnings of each of the MAP areas, (b) have performed well in other assessment contexts, and (c) have historical response data that are relatively consistent with the measurement scales and the Rasch measurement model, which were used to calibrate the items (p. 148).

For seventh grade, the test-retest reliability is .89. The internal consistency for seventh grade students is .94 for mathematics (NWEA, 2004). Validity evidence is in the form of concurrent validity comparing test questions to state Content Standards to test questions. The validity is expressed as a Pearson correlation coefficient. A strong relationship is indicated when the correlation is in the mid .80s. For validity, NWEA matched test questions to state content standards to test questions. The concurrent validity between the *Nevada Criterion Referenced Assessment* and the MAP yielded correlation results of .76 in Mathematics (NWEA, 2004). This instrument was chosen for its high reliability and evidence that it's valid.

Research Question #2

The School Attitude Assessment Survey-Revised (SAAS-R) was the instrument used to measure student attitudes. The SAAS-R is a validated survey instrument developed by McCoach and Siegle (2003). The survey was validated through a pilot sample of 942 secondary students diverse in demographic and achievement status. This survey instrument consists of 35 Likert-scale response-type statements that measure the following components of student attitude: (a) attitude toward classes and teachers, (b) attitude toward school, (c) goal valuation, (d) motivation and self-regulation, and (e) academic self-perceptions. In their pilot sample, McCoach and Siegle found that the internal consistency for each scale exceeded .85, showing adequate reliability. Each statement is measured on a 7 point Likert scale, with a “1” being strongly disagree, and a “7” being strongly agree (Suldo et al., 2007). This instrument will be used to measure the attitudes of students in the treatment group to those in the control group. The survey was given at the end of the study to both the treatment and control group.

Materials

This study required Nintendo DS systems and copies of *Brain Age 2* for students in the treatment group. One of the four computer labs at the school was used to administer the MAP testing portion of the study. Headphones were also required for each Nintendo DS so that the sound did not become distracting.

Variables

What impact does playing *Brain Age 2* on a Nintendo DS have on student achievement in 7th grade math classes, as measured by the MAP test? For this research

question, the independent variable is student use of the Nintendo DS. The dependent variable is student achievement measured by the MAP test. The second research question describes students' attitudes toward different variables.

Data collection

Data was collected during the second quarter of the school year (October-December, 2009). Students randomly selected to participate in the study were assigned to a class during one of their elective periods where they played the Nintendo DS 15 minutes daily for 9 weeks. All students took the MAP test during their math class within the first week of the quarter. If students were absent when the test was administered, they took the test when they returned to school.

The survey was administered during their math class the last day of the quarter. The researcher assigned a unique code to each participant. That code was used on data collection instruments. See the table below for how the code will be determined.

Table 4: Determining code for each participant

| Name | Group: Control Group (C) or Treatment Group (T) | Unique Number (1-80) | Student Code: Combine group and number |
|-----------|---|----------------------|--|
| Joe Davis | C | 1 | C1 |

Administration of the MAP test and School Attitude Assessment Survey

The Northwest Evaluation Association's (NWEA) Measures of Academic Progress (MAP) was administered twice to students, once during the first week of the quarter and once during the last week of the quarter. The test can take anywhere from

30-90 minutes to complete. Students completed the test in one of the school's four computer labs. Student scores were recorded on an Excel spreadsheet.

The School Attitude Assessment Survey-Revised (SAAS-R) was used to measure student attitude. The survey takes 5-10 minutes to complete. Students completed the survey on the last day of the quarter in their math class. The survey was placed on two different colors of paper, so the researcher can distinguish between the control group and treatment group. The math teacher received a list of which students should be given which color of paper. Data collected was recorded on an Excel spreadsheet.

Data Analysis

SPSS (Statistical Package for the Social Sciences) was used for data analysis. This software was used because it easily imports data from Microsoft Excel. A statistician assisted with the data analysis.

Research Question #1

1. What impact does playing Brain Age on a Nintendo DS have on student achievement in a 7th grade math class, as measured by the MAP test?

The main objective of the study was to test whether there is any significant difference in the mean score before playing the game and after playing *Brain Age 2*. A paired comparison was used to analyze scores on the MAP test for statistically significant differences between the pretest and posttest. Since there are two measurements on the same sample, the paired t-test was used for analysis. Analysis was calculated at a 95% confidence level. This test works under the assumption that the data follows a normal distribution. Before using this test, the normality of the data was tested.

Research Question #2

2. What are students' (a) attitude toward classes and teachers, (b) attitude toward school (c) goal valuation (d) motivation and self-regulation, and (e) academic self perceptions?

The data collected from the School Attitude Assessment Survey-Revised (SAAS-R) was analyzed with nonparametric statistics. The survey was given to both the control and treatment groups at the conclusion of the study. The mean and standard deviation was calculated for each statement on the survey and then analyzed using the rubric written by the survey's creators.

Limitations of the Study

1. The population sample was 80 students in seventh grade at an urban school in Colorado, and results may not be similar in other grades or districts with varying demographics.
2. The researcher taught the class where students played the Nintendo DS daily.
3. Students had the freedom to choose what activities they played within the game. All activities are seen as equal in value in the researcher's opinion, and the study focused on the game in general.
4. Some students never used a Nintendo DS before.
5. Some students have never taken an assessment on the computer before.

Issues related to validity

Experimental Mortality

The school being studied is a transient area. Many students move several times throughout the year, and 57% of students that leave go to a different school in the district.

In the treatment group, two students switched schools during the study, and three students were absent for the post test. Since Winter Break was the following week, they were not able to take the MAP at the end of the second quarter, so their data was dropped from the study.

CHAPTER IV: FINDINGS

Introduction

In this chapter, the data will be presented, analyzed, and explained. The data collected included student pre and posttest scores on the Northwest Evaluation Association's (NWEA) Measures of Academic Progress (MAP) test and results from the School Attitude Assessment Survey-Revised (SAAS-R). Data were analyzed using Microsoft Excel and SPSS (Statistical Package for the Social Sciences). Chapter 4 is organized by research question.

Results

1. MAP Test score for treatment group:

Descriptive statistical summary of Pre & Post MAP test scores are presented in Table 5. The box plot of distribution of scores is given in Figure 2.

| | N | Minimum | Maximum | Mean | | Std. Deviation |
|----------|-----------|-----------|-----------|-----------|------------|----------------|
| MAP test | Statistic | Statistic | Statistic | Statistic | Std. Error | Statistic |
| Pre | 35 | 196.00 | 235.00 | 211.94 | 1.7822 | 10.5438 |
| Post | 35 | 190.00 | 237.00 | 213.86 | 1.8302 | 10.8279 |

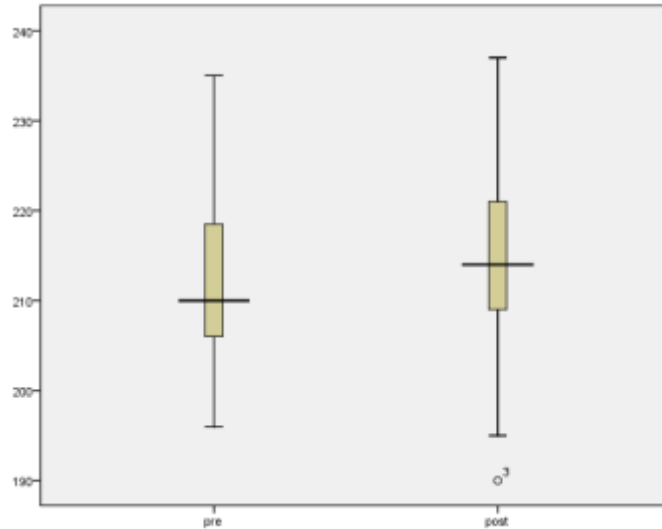


Figure 2: Box plot of Exam scores for pre and post MAP test scores

Pretest scores range from 196 to 235 with a mean of 211.94 and standard deviation of 10.5438. Posttest scores range from 190 to 237 with a mean score of 213.86 and standard deviation of 10.828.

The normality assumption of scores was tested and the summary of results is presented in Table 6. Figures 3 and 4 give a q-q normal plot for the pre and posttest. The normality test was conducted using Kolmogorov Smirnov and Shapiro Wilk's tests. Both these test procedures give a p value of more than 0.05. This indicates that the data follows a normal distribution, so the use of a parametric procedure is justified.

| Table 6: Tests of Normality of Exam scores for treatment group | | | | | | |
|---|---------------------------------|----|-------|--------------|----|-------|
| | Kolmogorov-Smirnov ^a | | | Shapiro-Wilk | | |
| | Statistic | df | Sig. | Statistic | df | Sig. |
| Pre | .087 | 35 | 0.200 | 0.963 | 35 | 0.281 |
| Post | .110 | 35 | 0.200 | 0.969 | 35 | 0.412 |

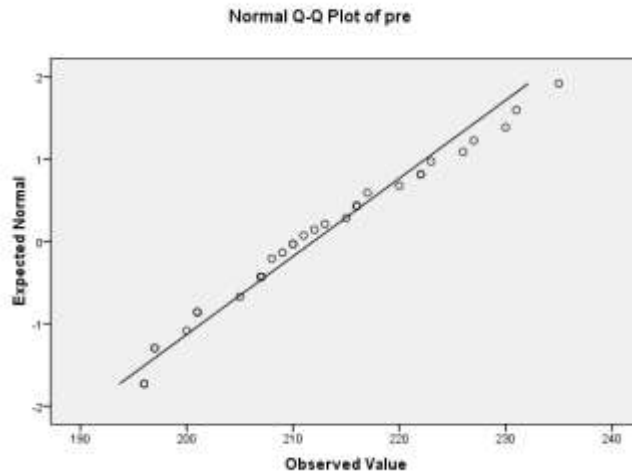


Figure 3: Normal Q – Q plot of Pre intervention exam score

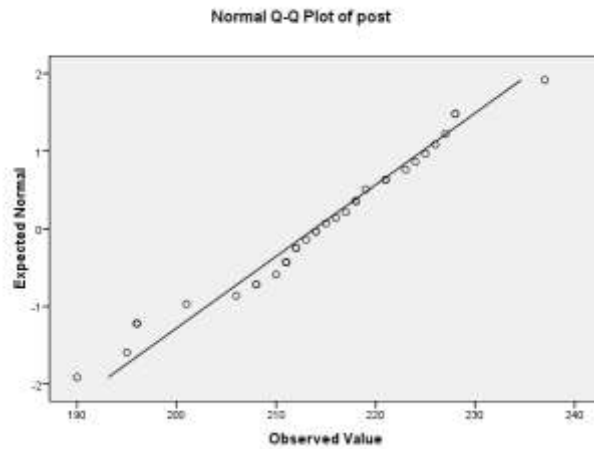


Figure 4: Normal Q – Q plot of Post intervention exam score

To test whether there is any significant difference in the mean score for pre and post intervention groups, a paired t-test was done. Results of the paired t-test are presented in Table 7.

| Table 7: Results Summary of Paired Samples Test | | | | | | | | |
|---|--------------------|----------------|-----------------|-------------------------|--------|--------|----|---------|
| Pair | Paired Differences | | | | | t | df | P value |
| | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval | | | | |
| | | | | Lower | Upper | | | |
| pre - post | -1.91429 | 8.10001 | 1.36915 | -4.69673 | .86816 | -1.398 | 34 | 0.171 |
| Correlation coefficient = 0.713, p < 0.0001 | | | | | | | | |

Correlation coefficient (paired) between pre and post exam scores is 0.713 and the corresponding p value is less than 0.05 indicating significant correlation between pre and post intervention score. However, test for difference in means gives a p value 0.171 ($t_{34} = 1.398$, $p = 0.171$). This means that at a 0.05 level of significance, there is no evidence to show that there is significant difference between pre and post examination scores. At a 0.05 level of significance, we do not reject the null hypothesis that there is no significant difference in the mean score of pre and post MAP test scores.

2. MAP Test scores for control group

Descriptive statistical summary of Pre & Post intervention scores is presented in Table 8. Box plot of the distribution of scores is given in Figure 5.

| Table 8: Descriptive Statistics of exam scores for control group | | | | | | |
|--|-----------|-----------|-----------|-----------|------------|----------------|
| Intervention | N | Minimum | Maximum | Mean | | Std. Deviation |
| | Statistic | Statistic | Statistic | Statistic | Std. Error | Statistic |
| Pre | 40 | 196.00 | 243.00 | 214.57 | 1.6832 | 10.6455 |
| Post | 36 | 190.00 | 337.00 | 218.14 | 3.7605 | 22.5631 |

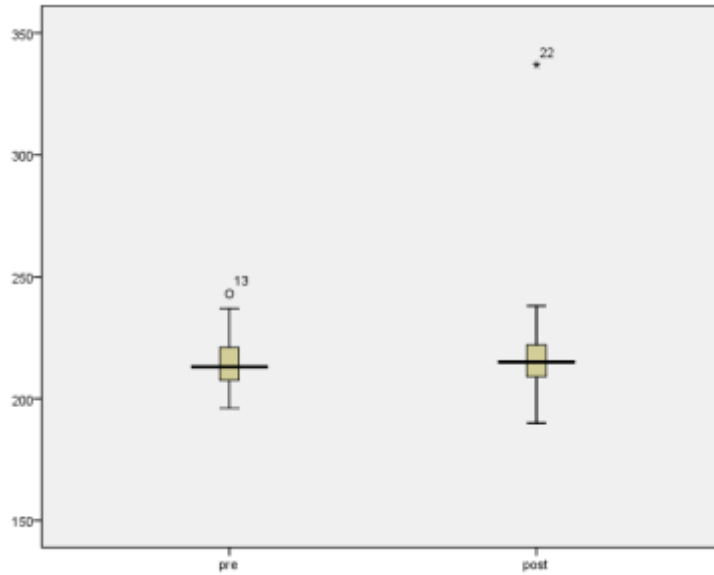


Figure 5: Box plot of Exam scores for pre and post intervention for control group

Pre intervention score ranges from 196 to 243 with a mean of 214.57 and standard deviation 10.6455. Post intervention score ranges from 190 to 337 with mean score of 218.14 and standard deviation 22.5631. The normality assumption of scores was tested and the summary of results is presented in Table 9. Figures 6 and 7 give a q-q normal plot for pre and post MAP test scores for the control group.

| Table 9: Tests of Normality of Exam scores for control group | | | | | | |
|--|---------------------------------|----|--------------------|--------------|----|-------|
| Intervention | Kolmogorov-Smirnov ^a | | | Shapiro-Wilk | | |
| | Statistic | df | Sig. | Statistic | df | Sig. |
| Pre | 0.091 | 36 | 0.200 [*] | 0.964 | 36 | 0.288 |
| Post | 0.276 | 36 | 0.000 | 0.558 | 36 | 0.000 |

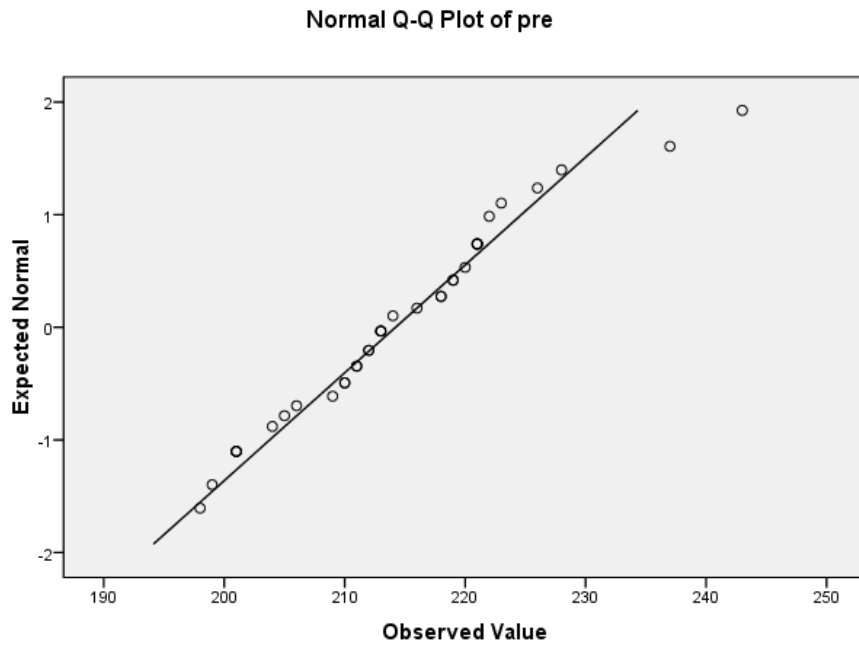


Figure 6: Normal Q – Q plot of Pre intervention exam score for control group

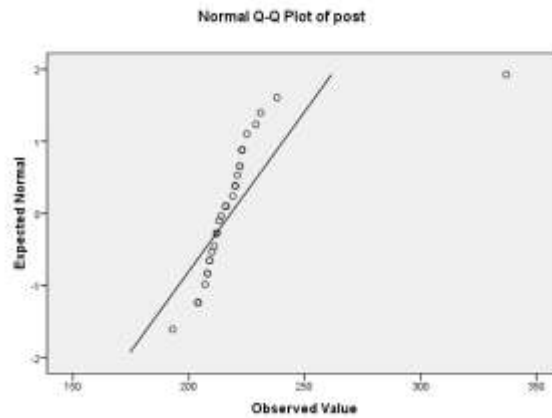


Figure 7: Normal Q – Q plot of Post intervention exam score for control group

The normality test was conducted using Kolmogorov Smirnov and Shapiro Wilk’s tests. Both these test procedures give a p value of more than 0.05 for pretest score, but for the posttest, the p value reported by both tests is less than 0.05. This indicates that the pretest data follows normal distribution, but the posttest data does not follow normal distribution.

Close observation of the box plot of the data shows that the post examination scores distribution has a significant outlier (case # 22 with a post intervention score of 334), so this score was deleted, and the descriptive measures were recalculated and the normality tests were done again (Table 10).

| Test | Kolmogorov-Smirnov | | | Shapiro-Wilk | | |
|------|--------------------|----|--------|--------------|----|-------|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| Pre | 0.101 | 35 | 0.200* | 0.954 | 35 | 0.150 |
| Post | 0.086 | 35 | 0.200* | 0.976 | 35 | 0.619 |

Recalculation of descriptive measures gives a mean score for post intervention as 214.7429 with a standard deviation of 9.832, and the normality assumption is satisfied as indicated by the results of Kolmogorov –Smirnov & Shapiro Wilks test ($P > 0.05$). Thus, the use of a parametric test to test the significance of difference in means is justified. To test whether there is any significant difference in the mean score for pre and posttests, a paired t-test is used. Results of the paired t-test are presented in Table 11.

| Pair | Paired Differences | | | | | t | df | P value |
|------------|--------------------|----------------|-----------------|-------------------------|--------|--------|----|---------|
| | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval | | | | |
| | | | | Lower | Upper | | | |
| pre - post | -0.914 | 6.90001 | 1.166 | -3.2845 | 1.4559 | -0.784 | 34 | 0.439 |

Correlation coefficient = 0.755, $p < 0.0001$

Correlation coefficient (paired) between pre and post exam scores is 0.755 and the corresponding p value is less than 0.05 indicating significant correlation between pre and post intervention score. However, the test for difference in means gives a p value of more than 0.05 ($t_{34} = 0.784$, $p = 0.439$). This means that at the 0.05 level of significance, there is no evidence to show that there is significant difference between pre and post test scores. At the 0.05 level of significance, we do not reject the null hypothesis that there is no significant difference in the mean score of pre and post tests.

Summary

From the above t- test results for treatment and control groups the difference in average MAP test score for Pre & Post intervention score is statistically not significant at the 0.05 level of confidence, so the hypothesis that playing *Brain Age 2* on the Nintendo DS affects the math ability or aptitude as measured by the MAP test is not supported.

2. Attitude Measurement

The School Attitude Assessment Survey-Revised (SAAS-R) is used to measure student attitude. The results from the survey are explained and analyzed below.

2.1 Academic Self-Perception

Table 12 presents the distribution of responses to seven different statements related to the academic self-perception factor on the survey.

Table 12: Academic Self Perception

| Group | Statement | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Total | Mean | SD |
|-----------|-----------|------------|-------------|-------------|--------------|--------------|--------------|-------------|-------------|-------|-------|
| Treatment | 1 | 2 (5.7) | 1 (2.9) | 1 (2.9) | 6 (17.1) | 8 (22.9) | 11 (31.4) | 6 (17.1) | 35 (100) | 5.114 | 1.586 |
| | 2 | 1 (2.9) | 1 (2.9) | 4 (11.4) | 4 (11.4) | 15 (42.9) | 7 (20.0) | 3 (8.6) | 35 (100) | 4.828 | 1.361 |
| | 3 | 3 (8.6) | 0 (0.0) | 3 (8.6) | 6 (17.1) | 9 (26.5) | 11 (32.4) | 2 (5.9) | 34 (100) | 4.735 | 1.582 |
| | 4 | 1 (2.9) | 3 (8.6) | 2 (5.7) | 4 (11.4) | 10 (28.6) | 10 (28.6) | 4 (11.4) | 34 (100) | 4.911 | 1.564 |
| | 5 | 2 (5.9) | 3 (8.8) | 4 (11.8) | 4 (11.8) | 8 (23.5) | 7 (20.6) | 6 (17.6) | 34 (100) | 4.706 | 1.801 |
| | 6 | 1 (2.9) | 3 (8.8) | 6 (17.6) | 7 (20.6) | 7 (20.6) | 5 (14.7) | 5 (14.7) | 34 (100) | 4.500 | 1.656 |
| | 7 | 3 (8.6) | 0 (0.0) | 5 (14.3) | 7 (20.0) | 5 (14.3) | 6 (17.1) | 9 (25.7) | 35 (100) | 4.857 | 1.849 |
| Control | 1 | 0 (0.0) | 0 (0.0) | 3 (8.3) | 7 (19.4) | 7 (19.4) | 12 (33.3) | 7 (19.4) | 36 (100) | 5.361 | 1.246 |
| | 2 | 1 (2.8) | 3 (8.3) | 5 (13.9) | 6 (16.7) | 12 (33.3) | 5 (13.9) | 4 (11.1) | 36 (100) | 4.555 | 1.538 |
| | 3 | 1 (2.8) | 1 (2.8) | 2 (5.6) | 6 (16.7) | 9 (25.0) | 8 (22.2) | 9 (25.0) | 36 (100) | 5.250 | 1.519 |
| | 4 | 1 (2.8) | 2 (5.6) | 1 (2.8) | 7 (19.4) | 7 (19.4) | 14 (38.9) | 4 (11.1) | 36 (100) | 5.083 | 1.461 |
| | 5 | 2 (5.6) | 4 (11.1) | 3 (8.3) | 9 (25.0) | 5 (13.9) | 5 (13.9) | 8 (22.2) | 36 (100) | 4.611 | 1.856 |
| | 6 | 0 (0.0) | 0 (0.0) | 2 (5.6) | 13 (36.1) | 10 (27.8) | 6 (16.7) | 5 (13.9) | 36 (100) | 4.972 | 1.158 |

| | | | | | | | | | | | |
|---|---|------------|------------|------------|------------|-------------|-------------|--------------|-------------|-------|-------|
| | 7 | 1 (2.8) | 2 (5.6) | 2 (5.6) | 3 (8.3) | 9 (25.0) | 5 (13.9) | 12 (33.3) | 36 (100) | 5.056 | 2.056 |
| <u>Statement Description :</u> | | | | | | | | | | | |
| Statement 1 = I am intelligent | | | | | | | | | | | |
| Statement 2 = I can learn new ideas quickly in school. | | | | | | | | | | | |
| Statement 3 = I am smart in school | | | | | | | | | | | |
| Statement 4 = I am good at learning new things in school. | | | | | | | | | | | |
| Statement 5 = School is easy for me | | | | | | | | | | | |
| Statement 6 = I can grasp complex concepts in school | | | | | | | | | | | |
| Statement 7 = I am capable of getting straight A's | | | | | | | | | | | |

In the treatment group, the mean score for the seven different statements ranged from 4.500 to 5.114. No statement received a mean score of more than 5.4 to qualify it as a normal or average. However, four out of the seven statements have a mean of more than 4.8 which qualifies for low average academic self perception. These four statements are:

- i. I am intelligent
- ii. I can learn new ideas quickly in school
- iii. I am good at learning new things in school.
- iv. I am capable of getting straight A's

The other three statements given below have a mean score less than 4.8 which qualify for a low academic self perception.

- i. I am smart in school
- ii. School is easy for me
- iii. I can grasp complex concepts in school

In summary, the academic self perception score in the treatment group is either low or low average.

In the control group, the mean ratings for different statements range from 4.555 to 5.361. The mean scores qualify for either low or low average. Five out of seven statements given below received a low average score with a mean of more than 4.8.

- i. I am intelligent
- ii. I am smart in school
- iii. I am good at learning new things in school.
- iv. I can grasp complex concepts in school
- v. I am capable of getting straight A's

The other two statements have a low mean score (less than 4.8).

- i. I can learn new ideas quickly in school.
- ii. I am good at learning new things in school.

Comparing the responses in the treatment and control groups, the mean response does not cross the low average cut off. However, in the control group, the statement “I can grasp complex concepts in school” has received a better perception score than in treatment group. In both the groups, the academic self-perception is low for statements based on intelligence in the school and whether the students find school easy. The overall academic self-perception is on the lower side among students irrespective of whether he/she was a part of the treatment or control group.

2.2 Attitude towards class and teachers

Table 13 presents the distribution of responses to different statements related to attitude towards classes and teachers.

| Table 13: Attitude towards class & teachers | | | | | | | | | | | |
|---|-----------|------------|-------------|-------------|-------------|--------------|--------------|--------------|-------------|-------|-------|
| Group | Statement | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Total | Mean | SD |
| Treatment | 1 | 1 (2.9) | 2 (5.7) | 3 (8.6) | 5 (14.3) | 10 (28.6) | 7 (20.0) | 7 (20.0) | 35 (100) | 5.000 | 1.590 |
| | 2 | 2 (5.7) | 0 (0.0) | 5 (14.3) | 5 (14.3) | 13 (37.1) | 6 (17.1) | 4 (11.4) | 35 (100) | 4.743 | 1.501 |
| | 3 | 1 (2.9) | 1 (2.9) | 1 (2.9) | 6 (17.6) | 6 (17.6) | 10 (29.4) | 9 (26.5) | 34 (100) | 5.382 | 1.518 |
| | 4 | 3 (8.6) | 0 (0.0) | 1 (2.9) | 4 (11.4) | 7 (20.0) | 13 (37.1) | 7 (20.0) | 35 (100) | 5.257 | 1.668 |
| | 5 | 0 (0.0) | 0 (0.0) | 0 (0.0) | 5 (14.3) | 9 (25.7) | 13 (37.1) | 8 (22.9) | 35 (100) | 5.686 | 0.993 |
| | 6 | 1 (2.9) | 0 (0.0) | 3 (8.6) | 5 (14.3) | 8 (22.9) | 5 (14.3) | 13 (37.1) | 35 (100) | 5.457 | 1.559 |
| | 7 | 3 (8.6) | 2 (5.7) | 3 (8.6) | 3 (8.6) | 10 (28.6) | 3 (8.6) | 7 (31.4) | 35 (100) | 4.943 | 1.939 |
| Control | 1 | 3 (8.3) | 3 (8.3) | 5 (13.9) | 8 (22.2) | 9 (25.0) | 6 (16.7) | 2 (5.6) | 36 (100) | 4.194 | 1.636 |
| | 2 | 2 (5.6) | 2 (5.6) | 5 (13.9) | 8 (22.2) | 6 (16.7) | 8 (22.2) | 5 (13.9) | 36 (100) | 4.611 | 1.695 |
| | 3 | 2 (5.6) | 1 (2.8) | 2 (5.6) | 6 (16.7) | 6 (16.7) | 8 (22.2) | 11 (30.6) | 36 (100) | 5.250 | 1.730 |
| | 4 | 2 (5.6) | 5 (13.9) | 2 (5.6) | 7 (19.4) | 10 (27.8) | 4 (11.1) | 4 (11.1) | 34 (100) | 4.228 | 1.848 |

| | | | | | | | | | | | |
|--|---|-------|--------|--------|--------|--------|--------|--------|-------|-------|-------|
| | 5 | 2 | 1 | 1 | 9 | 6 | 6 | 11 | 36 | 5.167 | 1.715 |
| | | (5.6) | (2.8) | (2.8) | (25.0) | (16.7) | (16.7) | (30.6) | (100) | | |
| | 6 | 1 | 0 | 4 | 8 | 7 | 4 | 12 | 36 | 5.222 | 1.606 |
| | | (2.8) | (0.0) | (11.1) | (22.2) | (19.4) | (11.1) | (33.3) | (100) | | |
| | 7 | 3 | 4 | 5 | 8 | 3 | 8 | 3 | 34 | 4.057 | 1.924 |
| | | (8.6) | (11.4) | (14.3) | (22.9) | (8.6) | (22.9) | (8.6) | (100) | | |

Statement Description :

Statement 1 = My classes are interesting

Statement 2 = I relate well to my teachers

Statement 3 = I like my teachers

Statement 4 = My teachers make learning interesting.

Statement 5 = My teachers care about me.

Statement 6 = Most of the teachers at this school are good teachers

Statement 7 = I like my classes.

In the treatment group the mean score for the seven statements ranges from 4.783 to 5.686. Five statements have mean score of more than 5.0 making them a relatively high or normal attitude towards class and teachers. These five statements are given below.

- i. My classes are interesting
- ii. I like my teachers
- iii. My teachers make learning interesting.
- iv. My teachers care about me.
- v. Most of the teachers at this school are good teachers

The other two statements given below have mean score less than 5.0 but more than 4.7 which qualify for an average attitude towards class and teachers.

- i. I relate well to my teachers
- ii. I like my classes.

In summary, the attitude towards class and teachers is normal except in the case of relating oneself to the class and liking the class.

In the control group, the mean ratings for different statements range from 4.057 to 5.250.

Only three statements given below have received a mean score of more than 4.7 which qualify for a normal response.

- i. I like my teachers
- ii. My teachers care about me.
- iii. Most of the teachers at this school are good teachers

Other four statements have mean score which qualify for low average attitude.

- i. My classes are interesting
- ii. My teachers make learning interesting.
- iii. I relate well to my teachers
- iv. I like my classes.

Comparing the response in treatment and control groups, we find that in the treatment group, the overall attitude towards teachers and classes is more positive than in the control group. While in both groups students like the teachers and perceive that teachers care about their students and are good, they do not seem to relate to the teachers and classes. The overall attitude towards classes and teachers is normal in treatment group while it is low in the control group. In both the groups, relating to teachers and liking the class have a low mean score.

2.3 Attitude towards school

Table 14 presents the distribution of responses to different statements related to attitude towards school.

| Table 14: Attitude towards school | | | | | | | | | | | |
|---|-----------|-------------|-------------|-------------|--------------|--------------|--------------|-------------|-------------|-------|-------|
| Group | Statement | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Total | Mean | SD |
| Treatment | 1 | 1 (2.9) | 3 (8.6) | 1 (2.9) | 6 (17.1) | 6 (17.1) | 12 (34.3) | 6 (17.1) | 35 (100) | 5.057 | 1.697 |
| | 2 | 2 (5.7) | 3 (8.6) | 4 (11.4) | 7 (20.0) | 7 (20.0) | 6 (17.1) | 6 (17.1) | 35 (100) | 4.600 | 1.769 |
| | 3 | 1 (2.9) | 1 (2.9) | 3 (8.6) | 8 (22.9) | 7 (20.0) | 13 (37.1) | 2 (5.7) | 34 (100) | 4.886 | 1.388 |
| | 4 | 0 (0.0) | 2 (5.7) | 4 (11.4) | 7 (20.0) | 3 (8.6) | 13 (37.1) | 6 (17.1) | 35 (100) | 5.114 | 1.511 |
| | 5 | 1 (2.9) | 2 (5.7) | 2 (5.7) | 10 (28.6) | 4 (11.4) | 9 (25.7) | 7 (20.0) | 35 (100) | 4.971 | 1.618 |
| Control | 1 | 4 (11.1) | 4 (11.1) | 2 (5.6) | 7 (19.4) | 4 (11.1) | 6 (16.7) | 9 (25.0) | 36 (100) | 4.583 | 2.075 |
| | 2 | 3 (8.6) | 4 (11.4) | 4 (11.4) | 6 (17.1) | 8 (22.9) | 6 (17.1) | 4 (11.4) | 35 (100) | 4.314 | 1.811 |
| | 3 | 5 (13.9) | 2 (5.6) | 5 (13.9) | 3 (8.3) | 10 (27.8) | 9 (25.0) | 2 (5.6) | 36 (100) | 4.278 | 1.846 |
| | 4 | 6 (16.7) | 3 (8.3) | 1 (2.8) | 7 (19.4) | 4 (11.1) | 9 (25.0) | 6 (16.7) | 36 (100) | 4.416 | 2.103 |
| | 5 | 5 (13.9) | 4 (11.1) | 4 (11.1) | 11 (30.6) | 5 (13.9) | 5 (13.9) | 2 (5.6) | 36 (100) | 3.833 | 1.748 |
| <u>Statement Description :</u> | | | | | | | | | | | |
| Statement 1 = I am glad that I go to this school. | | | | | | | | | | | |

Statement 2 = This is a good school.

Statement 3 = This school is a good match for me.

Statement 4 = I like this school.

Statement 5 = I am proud of this school.

In the treatment group, the mean score for the five different statements ranges from 4.600 to 5.114. All the statements have a mean score of 4.4 which qualifies for a normal or average attitude towards school. In summary, the attitude towards school in the treatment group is normal. In the control group, the mean ratings for different statements range from 3.833 to 4.583. Only two statements have a mean score of more than 4.4. These statements given below indicate a normal attitude.

iii. I am glad that I go to this school

iv. I like this school

The other three statements have mean scores qualifying for low average.

Comparing the responses in the treatment and control groups, we find that in both groups, students like the school. In the treatment group, all the statements received a score of normal, but in the control group the attitude is low average for aspects of being proud about the school, the school is good, and that it is a good match for the students. Overall, the attitude is more favorable to the school in the treatment group than in the control group.

2.4 Attitude towards goal evaluation

Table 15 presents the distribution of responses to different statements related to goal valuation.

| Table 15: Attitude towards goal evaluation | | | | | | | | | | | |
|--|-----------|------------|------------|------------|-------------|-------------|--------------|--------------|-------------|-------|-------|
| Group | Statement | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Total | Mean | SD |
| Treatment | 1 | 1 (2.9) | 2 (5.9) | 1 (2.9) | 0 (0.0) | 1 (2.9) | 8 (23.5) | 21 (61.8) | 34 (100) | 6.117 | 1.628 |
| | 2 | 0 (0.0) | 0 (0.0) | 0 (0.0) | 1 (2.9) | 3 (8.6) | 10 (28.6) | 21 (60.0) | 35 (100) | 6.457 | 0.78 |
| | 3 | 1 (2.9) | 0 (0.0) | 2 (5.7) | 3 (8.6) | 8 (22.9) | 12 (34.3) | 9 (25.7) | 35 (100) | 5.543 | 1.379 |
| | 4 | 0 (0.0) | 0 (0.0) | 0 (0.0) | 3 (8.6) | 3 (8.6) | 7 (20.0) | 22 (62.9) | 35 (100) | 6.371 | 0.973 |
| | 5 | 0 (0.0) | 1 (2.9) | 1 (2.9) | 2 (5.7) | 6 (17.1) | 8 (22.9) | 17 (48.6) | 35 (100) | 6.000 | 1.283 |
| | 6 | 0 (0.0) | 1 (2.9) | 0 (0.0) | 4 (11.8) | 2 (5.9) | 11 (32.4) | 16 (47.1) | 34 (100) | 6.058 | 1.229 |
| Control | 1 | 1 (2.9) | 0 (0.0) | 0 (0.0) | 1 (2.9) | 3 (8.6) | 3 (8.6) | 27 (77.1) | 36 (100) | 6.486 | 1.221 |
| | 2 | 1 (2.9) | 0 (0.0) | 0 (0.0) | 1 (2.9) | 2 (5.7) | 3 (8.6) | 28 (80.0) | 35 (100) | 6.543 | 1.196 |
| | 3 | 0 (0.0) | 1 (2.9) | 2 (5.7) | 5 (14.3) | 3 (8.6) | 6 (17.1) | 18 (51.4) | 35 (100) | 5.857 | 1.478 |
| | 4 | 0 (0.0) | 0 (0.0) | 0 (0.0) | 3 (8.3) | 3 (8.3) | 6 (16.7) | 24 (66.7) | 36 (100) | 6.417 | 0.967 |
| | 5 | 0 (0.0) | 0 (0.0) | 2 (5.6) | 2 (5.6) | 3 (8.3) | 6 (16.7) | 23 (63.9) | 36 (100) | 6.278 | 1.186 |

| | | | | | | | | | | | |
|--|---|-------|-------|-------|-------|-------|--------|--------|-------|-------|-------|
| | 6 | 0 | 0 | 2 | 1 | 4 | 6 | 23 | 36 | 6.306 | 1.142 |
| | | (0.0) | (0.0) | (5.6) | (2.8) | 11.1) | (16.7) | (63.9) | (100) | | |
| <u>Statement Description :</u> | | | | | | | | | | | |
| Statement 1 = I want to get good grades in the school. | | | | | | | | | | | |
| Statement 2 = Doing well in school is important to my future career goals. | | | | | | | | | | | |
| Statement 3 = Doing well in school is one of my goals. | | | | | | | | | | | |
| Statement 4 = It is important to get good grades in school. | | | | | | | | | | | |
| Statement 5 = I want to do my best in school | | | | | | | | | | | |
| Statement 6 = It is important for me to do well in school | | | | | | | | | | | |

In the treatment group, the mean score for the different statements ranges from 5.543 to 6.457. Five statements have a mean score of more than 6.0 indicating students have a relatively high or normal attitude towards goal valuation. The only statement that has a low average score is “Doing well in school is one of my goals”.

In summary, the attitude towards goal valuation in treatment group is normal or average. In the control group, the mean ratings for different statements range from 5.857 to 6.486. Five statements have a mean score of more than 6.0 indicating students have a relatively high or normal attitude towards goal valuation. The only statement that has a low average score is “Doing well in school is one of my goals”. In summary, the attitude towards goal valuation in treatment group is normal or average.

Comparing the responses in the treatment and control groups, the attitude towards goal valuation is similar in both the control and treatment groups.

2.5 Attitude towards motivation and self-regulation

Table 16 presents the distribution of responses to different statements related to attitude towards motivation and self-regulation.

| Table 16: Attitude towards motivation and self-regulation | | | | | | | | | | | |
|--|-----------|-------------|-------------|-------------|-------------|--------------|--------------|--------------|-------------|-------|-------|
| Group | Statement | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Total | Mean | SD |
| Treatment | 1 | 5 (14.3) | 1 (2.9) | 3 (8.6) | 4 (11.4) | 8 (22.9) | 9 (25.7) | 5 (14.3) | 35 (100) | 4.600 | 1.943 |
| | 2 | 1 (2.9) | 0 (0.0) | 4 (11.4) | 3 (8.6) | 10 (28.6) | 11 (31.4) | 6 (17.1) | 35 (100) | 5.229 | 1.416 |
| | 3 | 0 (0.0) | 4 (11.4) | 5 (14.3) | 9 (25.7) | 5 (14.3) | 7 (20.0) | 5 (14.3) | 35 (100) | 4.600 | 1.594 |
| | 4 | 2 (5.7) | 1 (2.9) | 3 (8.6) | 4 (11.4) | 12 (34.3) | 10 (28.6) | 3 (8.6) | 35 (100) | 4.857 | 1.517 |
| | 5 | 1 (2.9) | 2 (5.7) | 4 (11.4) | 3 (8.6) | 8 (22.9) | 9 (25.7) | 8 (22.9) | 35 (100) | 5.114 | 1.659 |
| | 6 | 1 (2.9) | 2 (5.7) | 5 (14.3) | 4 (11.4) | 7 (20.0) | 11 (31.4) | 5 (14.3) | 35 (100) | 4.914 | 1.616 |
| | 7 | 4 (11.4) | 6 (17.1) | 1 (2.9) | 4 (11.4) | 9 (25.7) | 6 (17.1) | 5 (14.3) | 35 (100) | 4.314 | 1.996 |
| | 8 | 2 (5.7) | 1 (2.9) | 3 (8.6) | 6 (17.1) | 3 (8.6) | 13 (37.1) | 7 (20.0) | 35 (100) | 5.114 | 1.711 |
| | 9 | 2 (5.7) | 2 (5.7) | 3 (8.6) | 2 (5.7) | 9 (25.7) | 8 (22.9) | 9 (25.7) | 35 (100) | 5.114 | 1.778 |
| | 10 | 2 (5.7) | 2 (5.7) | 0 (0.0) | 8 (22.9) | 7 (20.0) | 6 (17.1) | 10 (28.6) | 35 (100) | 5.114 | 1.745 |
| | | | | | | | | | | | |
| Control | 1 | 2 (5.6) | 2 (5.6) | 6 (16.7) | 8 (22.2) | 4 (11.1) | 8 (22.2) | 6 (16.7) | 36 (100) | 4.611 | 1.761 |
| | 2 | 0 (0.0) | 0 (0.0) | 3 (8.3) | 8 (22.2) | 8 (22.2) | 10 (27.8) | 7 (19.4) | 36 (100) | 5.277 | 1.256 |
| | 3 | 0 (0.0) | 2 (5.6) | 6 (16.7) | 7 (19.4) | 9 (25.0) | 5 (13.9) | 7 (19.4) | 36 (100) | 4.833 | 1.521 |

| | | | | | | | | | | | |
|--|----|------------|------------|-------------|--------------|--------------|--------------|--------------|-------------|-------|-------|
| | 4 | 1 (2.8) | 2 (5.6) | 1 (2.8) | 8 (22.2) | 7 (19.4) | 11 (30.6) | 6 (16.7) | 36 (100) | 5.083 | 1.519 |
| | 5 | 2 (5.6) | 2 (5.6) | 1 (2.8) | 6 (16.7) | 11 (30.6) | 7 (19.4) | 7 (19.4) | 36 (100) | 4.972 | 1.647 |
| | 6 | 0 (0.0) | 2 (5.6) | 4 (11.1) | 9 (25.0) | 7 (19.4) | 10 (27.8) | 4 (11.1) | 36 (100) | 4.861 | 1.396 |
| | 7 | 1 (2.8) | 3 (8.3) | 1 (2.8) | 12 (33.3) | 8 (22.2) | 7 (19.4) | 4 (11.1) | 36 (100) | 4.667 | 1.493 |
| | 8 | 1 (2.8) | 2 (5.6) | 2 (5.6) | 4 (11.1) | 8 (22.2) | 7 (19.4) | 12 (33.3) | 36 (100) | 5.361 | 1.659 |
| | 9 | 0 (0.0) | 2 (5.6) | 1 (2.8) | 7 (19.4) | 9 (25.0) | 11 (30.6) | 6 (16.7) | 36 (100) | 5.222 | 1.333 |
| | 10 | 2 (5.6) | 2 (5.6) | 1 (2.8) | 10 (27.8) | 7 (19.4) | 8 (22.2) | 6 (16.7) | 36 (100) | 4.833 | 1.648 |

Statement Description :

Statement 1 = I check my assignment before turning it in.

Statement 2 = I work hard at school.

Statement 3 = I am self motivated to do my school work.

Statement 4 = I complete my school work regularly.

Statement 5 = I am organized about my school work.

Statement 6 = I use a variety of strategies to learn new material.

Statement 7 = I spend a lot of time on my school work.

Statement 8 = I am a responsible student

Statement 9 = I put a lot of effort in to my school work.

Statement 10 = I concentrate on my school work.

In the treatment group, the mean score for the ten different statements ranges from 4.314 to 5.229. Seven statements have a mean score of more than 4.7 indicating students have a relatively high or normal attitude towards motivation and self-regulation. The other

three statements given below have a mean score of less than 4.7 which indicate students have a low average attitude towards motivation and self-regulation.

- i. I check my assignment before turning it in.
- ii. I am self motivated to do my school work.
- iii. I spend a lot of time on my school work.

In the control group, the mean ratings for different statements range from 4.611 to 5.361. Eight statements have a mean score of more than 4.7 indicating students have a relatively high or normal attitude towards motivation and self-regulation. The other two statements given below have a mean score of less than 4.7 which indicate students have a low average attitude towards motivation and self-regulation.

- iv. I check my assignment before turning it in.
- v. I spend a lot of time on my school work.

Comparing the response in treatment and control groups, we find that overall attitude in treatment and control group is similar.

Summary

To assess the overall attitude of students, a variable was created for each dimension by calculating the mean rating of different statements forming that dimension. The calculated mean for a dimension like academic self-perception represents a student's overall average rating for the dimension based on the mean of the ratings given by that student for all the statements forming the dimension academic self-perception.

Descriptive summary measures based on these variables for the treatment and control groups are presented in tables 17 and 18. For Academic self respect the mean attitude

score indicates a low average score (4.793) in the treatment group, and in the control group, the mean attitude score also indicates a low average score (4.9841). For attitude towards classes and teachers, the mean attitude score indicates a normal / average mean score (5.199) in the treatment group, and the control group indicates a low average mean score (4.684). For attitude towards school, the mean attitude score indicates a normal / average (4.925) for the treatment group, and the control group indicates a low average mean score (4.281). For attitude towards goal valuation, the mean attitude score indicates a normal / average mean score (6.09) for the treatment group and normal/ average mean score (6.309) for the control group. For attitude towards motivation and self-regulation the mean attitude score indicates a normal / average mean score (4.897) in the treatment group and a normal / average mean score (4.972) in the control group.

| Table 17: Descriptive Statistics for Mean ratings of factors for treatment group | | | | | |
|---|---------|--------|---------|----------|---------|
| Statistic | meanasp | meantc | meansch | meangoal | meanmot |
| Mean | 4.793 | 5.199 | 4.925 | 6.090 | 4.897 |
| Std. Error of Mean | 0.199 | .1875 | .2136 | 0.1557 | 0.240 |
| Median | 4.857 | 5.285 | 5.000 | 6.333 | 5.30 |
| Std. Deviation | 1.1782 | 1.1092 | 1.264 | 0.921 | 1.425 |
| Minimum | 1.57 | 2.71 | 2.40 | 3.33 | 1.50 |
| Maximum | 6.86 | 7.00 | 7.00 | 7.00 | 6.80 |
| meanasp = Mean for academic self perception aspect meantc = Mean for attitude towards classes and teachers meansch=Mean for attitude towards school meangoal = Mean for attitude towards goal valuation meanmot=Mean for attitude towards motivation and self regulation. | | | | | |

| Table 18: Descriptive Statistics for Mean ratings of factors for control group | | | | | |
|---|---------|--------|---------|----------|---------|
| Statistic | meanasp | meantc | meansch | meangoal | meanmot |
| Mean | 4.9841 | 4.6839 | 4.2806 | 6.3093 | 4.9722 |
| Std. Error of Mean | 0.1884 | .20883 | .26965 | 0.1352 | 0.1814 |
| Median | 5.1429 | 4.9286 | 4.500 | 6.733 | 5.0500 |
| Std. Deviation | 1.1309 | 1.2529 | 1.6179 | 0.8111 | 1.0885 |
| Minimum | 2.57 | 2.14 | 1.00 | 4.17 | 2.30 |
| Maximum | 6.71 | 6.71 | 7.00 | 7.00 | 7.00 |

CHAPTER V: SUMMARY AND CONCLUSIONS

The purpose of this study was to determine how use of the Nintendo DS, one alternative technology, impacts student achievement in math. The study also examined student attitude toward learning in their school when the Nintendo DS was added to the curriculum. This chapter addresses the following topics: conceptual support, findings, recommendations for future research, methodological considerations, conclusions, and closing comments.

Conceptual Support

A literature review was performed to provide an overview of the research available how using video games as an instructional tool impacts student achievement in math. The areas of research that emerged in the literature review were: (a) millennial learners, (b) video games as instructional tools, and (c) math instruction in the United States.

An essential component of facilitating learning is understanding learners. The learners in our schools today are different than any previous generation that has come before them. Howe and Strauss labeled the students in our classrooms today millennials; they represent the first generation that has spent their entire lives surrounded by technology (Howe and Strauss 2000, 2003). To millennials, technology has been around all their lives so it's not technology to them, it's a part of life. Millennials have grown up surrounded by technological innovations such as cell phones, MP3 players, digital cameras, and video games. In the classroom, millennials do not want lectures, multiple-choice quizzes, or memorizing long lists. They want collaborative assignments,

interactive lectures, technology, and varied software in the learning environment (Moore, 2005).

The literature on video games as instructional tools showed that many educators and researchers believe that video games can be a useful tool in teaching and learning. Video games include some of the best instructional techniques known to educators including engagement, fun, immediate feedback, and differentiation. Video games can help to engage students especially those who are not motivated to learn by traditional instruction. Video games are becoming a more integral part of society and because of that, they should be studied to see if there are ways they can be utilized in educational environments. If teachers want to reach their students, they must be knowledgeable about their culture and connect what goes on in the classroom to what goes on outside the classroom.

Under *No Child Left Behind*, every student must master mathematics and Language Arts standards by receiving a proficient score on state assessments by 2014 (US Department of Education, 2003a). Schools are held accountable for how well students perform on state assessments, so they are under pressure to increase student achievement. The debate over the best instructional methods for teaching math (“math wars”) has taken place for a long time, but no one approach has been shown to raise student achievement significantly. If neither the constructivist nor skills approach is effective in engaging students and helping them achieve at high levels, an innovation that supplements a school’s curriculum might help. Innovation is the introduction of something new, a new idea, method, or device (Merriam-Webster Online, n.d.). Other

industries have begun to use video games as an instructional tool. Businesses and the military use video games for training their employees (Prensky, 2001). It was the goal of this study to measure how the innovation of using video games as an instructional tool impacts student achievement in math.

Methods

This quasi-experimental study examined how playing Brain Age on a daily basis affects achievement in a math classroom. The design of the study consisted of a treatment/control group design. The treatment was the Nintendo DS. The population consisted of 80 students in two seventh grade classes in an urban school district in Colorado. The students involved in this study were from one of three sections of a course called “Math 7.” Students were in that class 96 minutes every day. In addition to the 96 minutes of daily instruction, 40 students were placed in a nine week elective class called “Technology 7” where they played the Nintendo DS daily for 15 minutes. The class was 46 minutes in length. The school’s technology curriculum was taught during the other 31 minutes. The Nintendo DS was integrated with the instruction presented in class.

The Northwest Evaluation Association’s (NWEA) Measures of Academic Progress (MAP) was used to measure student growth over the 9 weeks. The MAP test is a computer-adaptive assessment that will increase or decrease its difficulty level based on students’ answers to previous questions (NWEA, 2004-2006). The School Attitude Assessment Survey-Revised (SAAS-R) was the instrument used to measure student attitudes. This survey instrument consists of 35 Likert-scale response-type statements that measure the following components of student attitude: (a) attitude toward classes and teachers, (b) attitude toward school, (c) goal valuation, (d) motivation and self-regulation, and (e) academic self-

perceptions. Each statement is measured on a 7 point Likert scale, with a “1” being strongly disagree, and a “7” being strongly agree. The survey was given at the end of the study to both the treatment and control group.

Research Questions

1. What impact does playing *Brain Age 2* on a Nintendo DS have on student achievement in a math class?
2. What are students’ (a) attitude toward classes and teachers, (b) attitude toward school (c) goal valuation (d) motivation and self-regulation, and (e) academic self perceptions?

Findings

The purpose of this study was to examine how playing the Nintendo DS daily affects math achievement and student attitudes towards school and learning. The study was framed around the theoretical framework of engagement. Mihaly Csikzentmihalyi’s flow theory said that student engagement is highest when a combination of concentration, interest, and enjoyment were present and happening simultaneously in the learning environment. Participation was voluntary and students could drop out of the study at any time. No student dropped out of the study, which shows there was an interest and connection to the activity taking place during the study. Engagement in school is students being invested through participating and putting forth effort to learn. Students in the study fully participated for the duration of the study and put forth effort when playing *Brain Age 2* trying to beat their previous scores on various activities and trying to beat other students’ scores also.

The remainder of this section is organized by research question. Findings are restated in the following paragraphs for each research question. Based on the analysis of data in Chapter 4, the following findings are accepted:

Research Question 1: From the paired analysis done in chapter 4, the difference in average MAP test score for Pre & Post intervention score is statistically not significant at the 0.05 level of confidence, so the hypothesis that playing *Brain Age 2* on the Nintendo DS affects the math ability or aptitude as measured by the MAP test was not supported in this study. *Brain Age 2* was played daily for 9 weeks for fifteen minutes. The MAP test was used to measure student growth over the 9 weeks. The MAP test is a computer-adaptive assessment that will increase or decrease its difficulty level based on students' answers to previous questions, and it was chosen for its high reliability and evidence that it's valid (NWEA, 2004-2006).

Research Question 2: The calculated mean for each dimension on the School Attitude Assessment Survey-Revised (SAAS-R) showed differences between the treatment and control groups for the following dimensions: For attitude towards classes and teachers, the mean attitude score indicated a normal / average mean score (5.199) in the treatment group, and the control group indicated a low average mean score (4.684). For attitude towards school, the mean attitude score indicated a normal / average (4.925) for the treatment group, and the control group indicated a low average mean score (4.281). For Academic self-respect, the mean attitude score indicated a low average score (4.793) in the treatment group, and in the control group, the mean attitude score also indicated a low average score (4.9841). No differences existed in the survey results between the control

and treatment groups on the dimensions of goal valuation and motivation and self-regulation.

Methodological Considerations

This study had reliable participants. No one dropped out, and everyone returned their assent/consent forms in a timely manner. The data reflects seventy students instead of eighty because two students moved before the study was complete and eight students were absent for the posttest. Since Winter Break was the following week, testing students after two weeks might have affected the outcome, so those eight students were not given the posttest and their data was not included in the analysis. Ending the study the week before Winter Break affected the amount of data that was used in the analysis. While this study had reliable participants, the results of this study on 7th grade students in Colorado, may not be similar in other grades and districts with different demographics.

Data collection was done primarily through technology in this study. The pre and post test was given on the computer, and students used the Nintendo DS daily during the study. Students had varying degrees of experience with the Nintendo DS and with taking an assessment on the computer. Students' varying degrees of exposure to the technology was not a variable controlled in this study. Students do not take assessments on the computer in the school district studied. The district does not give the MAP test to all students every year, so some students might not have taken an assessment on the computer before. It can be assumed that students in this study had varying degrees of prior exposure to technological devices.

While students were playing *Brain Age 2* during the study, they had the freedom to choose what activities they played within the game. Students completed the Daily Training every day. To complete the Daily Training, students could complete any of the minigames. Within *Brain Age 2*, the minigames are not ranked by value. All the minigames are seen as equal in value in the researcher's opinion, and the study focused on the game in general. Students were not required to complete certain activities during the fifteen minutes.

The researcher taught the class where students played the Nintendo DS daily. Students were not able to play the Nintendo DS in their math class because the school district did not want to supplement the current math curriculum with a video game that research has not yet proven to impact student achievement. The researcher did not discuss or teach any mathematics during the study. The researcher monitored students to make sure they were playing the game and made sure students only played fifteen minutes.

Conclusions

The conclusions and recommendations that follow address both research questions. They are based on the findings from this study and the review of related literature.

The results of this study showed that playing *Brain Age 2* on the Nintendo DS does not affect math ability or aptitude as measured by the MAP test. Only one other study has been done on the impact of *Brain Age 2* on math achievement, and these results are not consistent with that study. A study in Scotland found that sixth grade students

who played *Brain Age 2* on the Nintendo DS at the start of their class for 20 minutes improved on their test scores 50% more than those that did not (Irvine, 2008). Slight differences existed in the methodology of the two studies, which could be the reason for different results. The study in Scotland used a younger population, students played first thing in the morning, and the pre and post test in that study was identical. In this study, the assessment used was loosely connected to the game in the sense that students were not being tested on specific math concepts that the game teaches. The test was used to see if the intervention of the exercises in *Brain Age 2* on the DS would result in more growth and higher achievement in math than if the DS had not been introduced. A major difference in the methodology was location of the studies. The two studies occurred in two different countries with different methods and curriculums for teaching mathematics.

The literature does recognize innovative approaches to teaching to be more effective than traditional instruction. In one study, students receiving non-traditional teaching methods (active learning, mastery learning, problem based learning, and peer tutoring) scored 10% higher on their exams (Horswill, 2002). Innovation is defined as the introduction of something new, a new idea, method, or device (Merriam-Webster Online, n.d.). This study attempted to use innovation to raise math achievement by introducing video games, specifically *Brain Age 2* and the Nintendo DS, into the classroom to supplement instruction. But the innovation was not used in the math classroom, it was used in the technology class and possibly, the transfer of knowledge from one class to the other did not take place or students did not connect what they were learning from the video game and what they were learning in math to one another. In the

study's design, discussion of math in the technology class was eliminated, and math was not taught in the technology class. *Brain Age 2* is intended for edutainment and if it's going to be used in the classroom, additional instruction by the math teacher may be necessary to help students connect what they're learning in the game to what they're learning in the math class.

When an innovation such as the Nintendo DS is introduced, people have varying degrees of experience and knowledge with it. To impact student achievement with technological innovations, a certain amount of knowledge and experience is required. The 2007 Trends in International Mathematics and Science Study (TIMSS) reported that achievement was highest among those students reporting using a computer at home and at school and lowest among students who do not use a computer at all or only use it at places other than home or school. Students in this study had varying degrees of experience with the Nintendo DS. Most students only used the Nintendo DS during the study and did not own their own device that they played outside of school. Of the few students that did have their own, not many owned *Brain Age 2*, so they only played that game during the study. This could've impacted the results in this study.

The middle school being studied uses a constructivist approach to teaching math with the *Connected Math Project (CMP)*, a complete mathematics curriculum for grades 6, 7, and 8. While the curriculum emphasizes the use of technology and named technology as one of the five fundamental mathematical and instructional themes used to guide the development of the curriculum, technology beyond a graphing calculator is rarely used at the seventh grade level (<http://www.math.msu.edu/cmp>). Students do all

the work with a pencil in a workbook. Five computer games created in 1996 are available to supplement the curriculum, but beyond that no discussion exists about how or what technology should be used to teach the curriculum.

With the *CMP* curriculum, students do become accustomed to learning math a certain way. Each unit is setup the same way with investigations that contain problem sets through sections the curriculum calls Applications, Connections, and Extensions (ACE). In the district studied, math instruction is structured the same way daily starting with a number talk and then moving through the sequence of Launch, Explore, and Summarize. Students get used to the methods in which they learn math, which becomes problematic when a new method to learn math is introduced such as video games. Students may not be receptive to this idea if they have never experienced it and it is taking place in a different class like it was in this study.

“Math wars” is the term used to describe the debate that goes on regarding the best approach to teaching math. The two approaches to teaching mathematics that exist in the United States today are the constructivist approach and the skills approach. The constructivist approach is based on the belief that students should be taught how to think through problems with an understanding of why the answer is correct. Just knowing the answer is not enough, and drilling basic facts and formulas is generally not part of the curriculum. This is referred to as “fuzzy math” by those that believe in the skills approach where students work on exercises and drills to master concepts (Borusk, 2003). The constructivist method does attempt to make a connection between math and students’ lives, but as Borusk (2003) says, “Too many children are reaching upper grades without

fundamental math skills, thanks to a curriculum that is too un-challenging, too much oriented toward making math likable or fun, and way too low on classic skills.” On the other hand, the skills approach does not relate to students’ lives, and it does not motivate students to want to take more math classes (Middleton & Spanias, 1999).

Similar to the math wars, video games can also take different approaches to teaching. Some take a skills approach that drills the player on concepts as seen in some of the minigames in *Brain Age 2*. Others take a more constructivist approach where the player is responsible for figuring out how to succeed at the game either through scenarios or challenges such as *America’s Army (AA)* where the player acts like a soldier and must perform training and demonstrate competence before participating in combat (Howard, 2006). Some video game players might prefer one type of video game over the other, but for learning, the type of game used to teach does impact results. This makes aligning the concepts that need to be learned with the concepts the video game teaches important. Businesses are using video games to train their employees (Prensky, 2001). Canon U.S.A. uses a video game that focuses on skills to train copier technicians. In the game, technicians must place the parts of the copier in the right spot. Hilton Garden Inn uses a scenario video game to teach its employees. In this game, employees are in a virtual hotel where they respond to typical requests from virtual guests. The millennials sitting in classrooms today want technology, and varied software in their learning environment (Moore, 2005). More research is needed on what video games do align with the content currently being taught in classrooms.

This study found that for attitude towards classes and teachers, the mean attitude score indicated a normal / average mean score (5.199) in the treatment group, and the control group indicated a low average mean score (4.684). For attitude towards school, the mean attitude score indicated a normal / average (4.925) for the treatment group, and the control group indicated a low average mean score (4.281). Students in the treatment group felt a deeper connection to their classes, their teachers, and their school than those in the control group. The results of the School Attitude Assessment Survey-Revised (SAAS-R) are consistent with the literature on the use of video games in the classroom. Mitchell and Saville-Smith (2004) found computer games help to engage learners, and in a study in Chile, the Nintendo Gameboy was introduced into disadvantaged classrooms. Researchers found that student motivation and interest were raised when video games were added into the curriculum (Rosas et al., 2003).

Engagement was used as the theoretical framework in this study. In order for students to be successful in school, they must be engaged. (Appleton et al., 2006). Engagement in school is students being invested through attending, participating, and putting forth effort to learn because they feel a sense of belonging and have support from their teachers, peers, and adults (Glanville & Wildhagen, 2007; Green, Miller, Crowson, Duke & Akey 2004; Klem & Connell, 2004; National Center for School Engagement, 2006b; Woolley & Bowen, 2007). John Dewey believed that teachers should create learning environments that were relevant and meaningful to students and that schools needed to change to meet the needs of individual students (Dewey, 1938). The goal of this study was to create an engaging learning environment based on what is known about

millennials and how they learn in an effort to raise student achievement. The results of the survey revealed a higher level of engagement in the treatment group than the control group. That higher level of engagement did not lead to higher achievement though. Students in the treatment group were more engaged in the school according to the survey results, but were they more engaged in their math class? For students to be engaged, an emotional connection to the content being covered is necessary. Emotion is what makes people pay attention, and when they're paying attention learning is taking place (Wolfe, 2001). That connection was created in the technology class because *Brain Age 2* uses many of the strategies required to create that connection such as engaging the senses, movement and music, and hands-on experiences (Kovalik & Olsen, 2001). Playing *Brain Age 2* in a separate technology class did not make the math class more engaging though; it made the technology class more engaging, which raises the question about where the Nintendo DS would be best utilized in a school setting. Studies have shown that low student achievement is not usually the result of low ability but a result of "low student interest in the content and value of what is being taught" (McLaughlin & Blank, 2004, p. 1). In order to utilize video games to engage students, more research is needed on the best ways to integrate video games into the curriculum.

This study found through the survey that for Academic self-respect, the mean attitude score indicated a low average score (4.793) in the treatment group, and in the control group, the mean attitude score also indicated a low average score (4.9841). When thinking about themselves, students generally did not agree with statements such as *I am intelligent, I can learn new ideas quickly in school, I am smart in school, I am good at*

learning new things in school, I can grasp complex concepts in school, and I am capable of getting straight As. If students don't believe they are intelligent or that they are doing well in school, that can be a barrier to achievement. That could have happened in this study, but it is unknown if that affected the results. "Perceived self-efficacy is defined as people's belief about their capabilities to produce designated level of performance that exercise influence over events that affect their lives. Self-efficacy beliefs determine how people feel, think, motivate themselves and behave" (Bandura, 1994). Students' perception of what they are capable of affects their motivation to learn in school. If students in this study had a weak self-efficacy, they might have seen the minigames in *Brain Age 2* as difficult, which could have affected their openness and willingness to learn from the game.

Since 97% of teens play computer, web, portable, or console games, 72% of teens play puzzle games, 59% play strategy games, and 49% play simulation games, bringing video games into the classroom would help create the relevant and meaningful learning environment that John Dewey talked about (Green & McNeese, 2007, p. 14).

Unfortunately, most schools ban video games instead of teaching with them, and more importantly showing students how they can learn from them. Students see video games as fun and not an activity commonly integrated into their classes at school. But if the school builds a culture that values gaming as an instructional tool, that might be what is needed for video games to positively impact student achievement. Research is needed on how to best build such a culture and the best ways to integrate video games into the classroom so the activity moves beyond just fun and into authentic learning.

Recommendations for Further Study

In March of 2010, the general manager of Nintendo Shigeru Miyamoto announced his next major project involves establishing the Nintendo DS as a learning tool in schools (Molina, B., 2010). More research needs to be done to determine what value the Nintendo DS has in the classroom. Currently, there are few quantitative studies that measure the impact of video games on student achievement and student attitude in school. The following are suggestions for future research.

1. A study similar to the one in this report but the Nintendo DS is integrated into the math class itself. The use of a larger population and a longer time frame are recommended.
2. A study of different video games for the Nintendo DS that support the curriculum at the middle school level.
3. A study that examines barriers preventing teachers from integrating video games into the classroom.
4. A study that looks at the most effective ways for integrating video games into the classroom (warm-up, to reinforce concepts, to assess students).

Closing Comments

A significant body of evidence does not exist yet to support best instructional use of video games in classrooms. While some question the use of video games in education, others argue that video games are one innovation that if introduced into the classroom, might change how teachers effectively engage learners (Squire & Jenkins, 2003).

Students in today's classrooms are different than any generation that has come before

them. If schools want to engage students, they must realize that today's learners are different, and they must teach them using the tools that they use to learn such as such as the Nintendo DS, cell phones, and iPods, not the tools that the teacher used to learn. Using forms of entertainment in the classroom is not a new practice. Television and movies, once considered innovative, are now common in classrooms everywhere (Shaffer, Squire, Halverson, & Gee, 2004). The results from this study show the potential alternative technologies such as the Nintendo DS have to engage students in the classroom. Hopefully through more research, the answer to whether or not video games can be used in the classroom to help raise student achievement can be found.

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APPENDIX A: School Attitude Assessment Survey

School Attitude Assessment Survey-Revised

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Instructions: This survey should take approximately 5 minutes to complete.

Part I: Please rate how strongly you agree or disagree with the following statements. In answering each question, use a range from (1) to (7) where (1) stands for **strongly disagree** and (7) stands for **strongly agree**. Please circle only one response choice per question.

| Statement | Strongly Disagree | Disagree | Slightly Disagree | Neither agree nor disagree | Slightly Agree | Agree | Strongly Agree |
|---|----------------------|----------|----------------------|-------------------------------|-------------------|-------|-------------------|
| 1. My classes are interesting. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 2. I am intelligent. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 3. I can learn new ideas quickly in school. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 4. I check my assignments before I turn them in. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 5. I am smart in school. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 6. I am glad that I go to this school. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 7. This is a good school. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8. I work hard at school. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 9. I relate well to my teachers. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 10. I am self-motivated to do my schoolwork. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 11. I am good at learning new things in school. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 12. This school is a good match for me. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 13. School is easy for me. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 14. I like my teachers. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 15. I want to get good grades in school. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 16. My teachers make learning interesting. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 17. My teachers care about me. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 18. Doing well in school is important for my future career goals. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 19. I like this school. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 20. I can grasp complex concepts in school. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 21. Doing well in school is one of my goals. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 22. I am capable of getting straight A's. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 23. I am proud of this school. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

| Statement | Strongly Disagree | Disagree | Slightly Disagree | Neither agree nor disagree | Slightly Agree | Agree | Strongly Agree |
|--|-------------------|----------|-------------------|----------------------------|----------------|-------|----------------|
| 24. I complete my schoolwork regularly. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 25. It's important to get good grades in school. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 26. I am organized about my schoolwork. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 27. I use a variety of strategies to learn new material. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 28. I want to do my best in school. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 29. It is important for me to do well in school. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 30. I spend a lot of time on my schoolwork. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 31. Most of the teachers at this school are good teachers. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 32. I am a responsible student. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 33. I put a lot of effort into my schoolwork. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 34. I like my classes. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 35. I concentrate on my schoolwork. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

1. Please circle the letter that represents your grade point average:

A B C D F

2. Please circle the appropriate letter to indicate the total years of school completed for each of your parents.

Mother: a. No H.S. diploma b. H.S. diploma c. Technical or Associates Degree
d. Undergraduate Degree e. Graduate Degree

Father: a. No H.S. diploma b. H.S. diploma c. Technical or Associates Degree
d. Undergraduate Degree e. Graduate Degree

3. Do you receive free or reduced lunch price at school? yes no

Thank you for your time!

School Attitude Assessment Survey- Revised

© D. B. McCoach, University of Connecticut, 2002

Scoring Rubric/Codebook

Academic Self-Perceptions: 7 Questions

Q2, Q3, Q5, Q11, Q13, Q20, Q22

Use mean scores.

Mean: 5.7

Standard deviation = .9

Above 5.4 = Average/Normal

4.8 to 5.4 = Low average

3.5 to 4.8 = Low

Below 3.5 = Very low

Attitudes toward teachers (and classes): 7 Questions

Q1, Q9, Q14, Q16, Q17, Q31, Q34

Mean: 5.3

Standard deviation = 1.1

Above 4.7 = Average/Normal

4.0 to 4.7 = Low average

2.5 to 4.0 = Low

Below 2.5 = Very low

Attitudes toward school: 5 questions

Q6, Q7, Q12, Q19, Q23

Mean: 5.1

Standard deviation= 1.4

Above 4.4 = Average/Normal

3.6 to 4.4 = Low average

1.5 to 3.6 = Low

Below 1.5 = Very low

Goal Valuation: 6 Questions

Q15, Q18, Q21, Q25, Q28, Q29

Mean: 6.3

Standard deviation= 1.0

Above 6.0 = Average/Normal

5.0 to 6.0 = Low average

3.5 to 5.0 = Low

Below 3.5 = Very low

Motivation/Self-Regulation: 10 questions

Q4, Q8, Q10, Q24, Q26, Q27, Q30, Q32, Q33, Q35

Mean: 5.1

Standard deviation= 1.3

Above 4.7 = Average/Normal

3.7 to 4.7 = Low average

1.6 to 3.7 = Low

Below 1.6 = Very low

APPENDIX C: Assent Form for Research: Gaming as a Pedagogical Tool

Dear Student,

You are invited to take part in a study that explores how video games impact student achievement. This study is being done by Mr. Gelman, a technology teacher. Please read this letter and ask any questions before you decide to be part of the study.

What we want to learn:

1. Does playing Brain Age on a Nintendo DS increase student achievement in math?
2. What is your attitude toward learning and the school?

What you will be asked to do:

1. Attend a technology class during the second quarter only where you will spend 15 minutes of the class playing *Brain Age 2*.
2. You will take a pre and a post test. **Your score on this test does not count on your report card.**
3. You will take a survey that asks you questions about your attitude toward learning and the school.

Voluntary Nature of the Study:

Your participation in this study is voluntary. If you choose not to participate, your grades will not be affected. If you choose to participate, you can drop out at any time. If you would like to drop out of the study, let Mr. Gelman or an administrator know. An alternative assignment on the computer will be provided if you choose to drop out.

Risks and Benefits of Being in the Study:

This study offers you the opportunity to participate in real research. All information collected will be kept private. In this study, your name will never be used. The researcher will never include any information that will make it possible to identify you in reports that are published. However, should any information contained in this study be the subject of a court order or lawful subpoena, the University of Denver might not be able to avoid compliance with the order or subpoena. Although no questions in this study address it, I am required by law to tell you that if information is revealed concerning suicide, homicide, or child abuse and neglect, it is required by law that this be reported to the proper authorities.

Questions:

Feel free to contact Mr. Gelman with any questions you have.

Statement of Assent:

I have read the above information, and I would like to participate in the study.

Printed Name of Student _____

Signature of Student _____

Date _____

Signature of Researcher _____

Date _____

APPENDIX D: Consent Form for Research: Gaming as a Pedagogical Tool

Dear Parent/Guardian,

Your student is invited to participate in a study to explore the impact of video games on student achievement. This study is being conducted by Adam Gelman, technology teacher and a doctoral student at the University of Denver.

Background Information:

The purpose of this study is to explore video games and their impact on math achievement among middle school students. The research questions are:

1. What impact does playing Brain Age on a Nintendo DS have on student achievement in a math class?
2. What are students' (a) attitude toward classes and teachers, (b) attitude toward school (c) goal valuation (d) motivation and self-regulation, and (e) academic self perceptions?

Procedures:

Students participating in this study will be asked to do the following things:

1. Attend a technology class during the second quarter only where they will spend 15 minutes of the class playing *Brain Age 2*. This class will take place during the regular school day.
2. Take a pre and a post test (MAP) to see if playing Brain Age 2 impacts their math achievement. **Students' score on this test will not count toward the report card.**
3. Students will take a survey at the end of the study that measures their attitude about learning and the school.

This signed consent form gives your permission for your student to participate in the activities listed above.

Voluntary Nature of the Study:

Student participation in this study is voluntary. If students initially decide to participate, they are free to drop out at any time during the study. If your student chooses to drop out of the study, please call the school and let an administrator or Mr. Gelman know. If your student chooses to drop out, an alternative activity on the computer will be provided.

Risks and Benefits of Being in the Study:

Due to the confidential nature of the data collection, there are no known risks involved for participants. This study offers students the unique opportunity to participate in real research.

Confidentiality:

The records of this study will be kept private. If this study is published, the researcher will not include any information that will make it possible to identify a participant. Only the researcher will have access to your student's data. However, should any information contained in this study be the subject of a court order or lawful subpoena, the University of Denver might not be able to avoid compliance with the order or subpoena. Although no questions in this study address it, I am required by law to tell you that if information is revealed concerning suicide, homicide, or child abuse and neglect, it is required by law that this be reported to the proper authorities.

Contacts and Questions:

The researcher conducting this study is Adam Gelman. The researcher’s adviser is Dr. Kent Seidel. If you have any questions, you may contact them at agelman@aps.k12.co.us or kent.seidel@du.edu. The phone number for Mr. Gelman is 303-340-0660 (school). Feel free to call him at your convenience. Dr. Seidel can be reached at 303-871-2509.

If you have any questions or concerns, you may also contact Susan Sadler, Chair, Institutional Review Board for the Protection of Human Subjects, at 303-871-3454, or Sylk Sotto-Santiago, Office of Research and Sponsored Programs at 303-871-4052 or write to either at the University of Denver, Office of Research and Sponsored Programs, 2199 S. University Blvd., Denver, CO 80208-2121

Statement of Consent:

I have read the above information. I consent to allowing my student to participate in the study.

Name of Student _____

Signature of Parent/Guardian _____

Date _____

Signature of Researcher _____

Date _____

[] Yes, I would like a copy of the final research report sent to my home.

Our email address is _____

Please give your street address in the box below if you prefer that the research report be sent through the US postal mail.

Thank you for carefully reading and considering this invitation!

-Mr. Gelman

APPENDIX E: Consent Form for Research: Gaming as a Pedagogical Tool

Dear Mr. Smith,

Students at your school are invited to participate in a study to explore the impact of video games on student achievement. This study is being conducted by Adam Gelman, technology teacher and a doctoral student at the University of Denver.

Background Information:

The purpose of this study is to explore video games and their impact on math achievement among middle school students. The research questions are:

1. What impact does playing Brain Age on a Nintendo DS have on student achievement in a math class?
2. What are students' (a) attitude toward classes and teachers, (b) attitude toward school (c) goal valuation (d) motivation and self-regulation, and (e) academic self perceptions?

Procedures:

Students participating in this study will be asked to do the following things:

1. Attend a technology class during the second quarter only where they will spend 15 minutes of the class playing *Brain Age 2*.
2. Take a pre and a post test (MAP) to see if playing Brain Age 2 impacts their math achievement. **Students' score on this test will not count toward the report card.**
3. Students will take a survey at the end of the study that measures their attitude about learning and the school.

This signed consent form gives your permission for students to participate in the activities listed above.

Voluntary Nature of the Study:

Student participation in this study is voluntary. If students initially decide to participate, they are free to drop out at any time during the study. If a student chooses to drop out, an alternative activity on the computer will be provided that meets the technology standards adopted by the district. Students can drop out by letting Mr. Gelman or an administrator know.

Risks and Benefits of Being in the Study:

Due to the confidential nature of the data collection, there are no known risks involved for participants. This study offers students the unique opportunity to participate in real research.

Confidentiality:

The records of this study will be kept private. If this study is published, the researcher will not include any information that will make it possible to identify a participant. Only the researcher will have access to the students’ data. However, should any information contained in this study be the subject of a court order or lawful subpoena, the University of Denver might not be able to avoid compliance with the order or subpoena. Although no questions in this study address it, I am required by law to tell you that if information is revealed concerning suicide, homicide, or child abuse and neglect, it is required by law that this be reported to the proper authorities.

Contacts and Questions:

The researcher conducting this study is Adam Gelman. The researcher’s adviser is Dr. Kent Seidel. If you have any questions, you may contact them at agelman@aps.k12.co.us or kent.seidel@du.edu. The phone number for Mr. Gelman is 303-340-0660 (school). Feel free to call him at your convenience. Dr. Seidel can be reached at 303-871-2509.

If you have any questions or concerns, you may also contact Susan Sadler, Chair, Institutional Review Board for the Protection of Human Subjects, at 303-871-3454, or Sylk Sotto-Santiago, Office of Research and Sponsored Programs at 303-871-4052 or write to either at the University of Denver, Office of Research and Sponsored Programs, 2199 S. University Blvd., Denver, CO 80208-2121.

Statement of Consent:

I have read the above information. I consent to allowing students to participate in the study.

Printed Name Principal _____

Signature of Principal _____

Date _____

Signature of Researcher _____

Date _____

A copy of the final research report will be given to the school once it is completed.

Thank you for carefully reading and considering this invitation!

-Mr. Gelman

APPENDIX F: District Permission to Research

August 20, 2009

Adam Gelman

Dear Adam Gelman:

Thank you for interest in conducting research in our school district. I am pleased to inform you that your study, "Mario Math with Millennials: The Impact of Playing the Nintendo DS on Student Achievement" has been reviewed and approved for implementation based on the conditions on the following page. Please review and return a signed copy of the conditions of approval to our office prior to initiation of the study.

Please let me know if you have any questions or require any other information and good luck with your study.

Sincerely,

John Smith