EFFECTS OF ONLINE VISUAL AND INTERACTIVE TECHNOLOGICAL TOOL (OVITT) ON EARLY ADOLESCENT STUDENTS' MATHEMATICS PERFORMANCE, MATH ANXIETY AND ATTITUDES TOWARD MATH

A DISSERTATION

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

IN THE GRADUATE SCHOOL OF THE

TEXAS WOMAN'S UNIVERSITY

DEPARTMENT OF FAMILY SCIENCES

COLLEGE OF PROFESSIONAL EDUCATION

BY

NKECHI ORABUCHI, B.A., M.A.T.

DENTON, TEXAS

DECEMBER 2013

DEDICATION

To my family

Eji mụ obi mụ niile wee n’ekele ụnụ maka aja nke ụnụ chụrụ, ndidi ụnụ nwere, nakwa agbamume nke ụnụ gbara mụ. Obi dị mụ ụtọ n’ebe ụnụ nọ.

ACKNOWLEDGMENTS

I must first thank the Lord Jesus Christ for helping me throughout this process because without Him I would not be here.

I want to show my appreciation to all who have supported me throughout my doctoral process. I want to thank my committee members Dr. Lin Moore, Dr. Katherine Rose, and Dr. Rhonda Buckley for working with me and helping me become a better student through their advice and experience within the field of family sciences. A special thanks goes to my committee chair, Dr. Moore, for being an understanding, patient, and helpful guide throughout the whole process. I also want to thank Dr. David Marshall for taking time out of his busy schedule to help me on some statistics. I truly appreciate it.

Also, thank you to the school district, school, and all the participants and their parents. I am thankful for the opportunity to conduct the study at the location and thankful that the parents of the students allowed their child to participate in the study.

In addition, I want to thank my family and friends for supporting me along the way. My parents, Dr. Iheanacho Orabuchi, Sr. and Mrs. Ngozi Orabuchi, have been encouraging me daily and reminding me constantly to work hard and finish strong. I thank them for their unconditional love and support. Also, thanks to all who were involved in this process with me whether big or small I appreciate the positive support.

Again, I must thank my Lord and Savior, Jesus Christ, for helping me throughout this long, difficult, yet rewarding process. I have definitely learned more about patience and endurance from this experience in my life. “Know ye not that they which run in a race run all, but one receiveth the prize? So run, that ye may obtain” 1 Corinthians 9:24KJV. The doctoral process, specifically the dissertation aspect, has been a race of endurance. It is long and takes a lot of work and perseverance which also applies to life as a whole. I have truly had to depend on the Lord to help me through and I can boldly say, “I can do all things through Christ which strengtheneth me”—Philippians 4:13KJV.

ABSTRACT

NKECHI ORABUCHI

EFFECTS OF ONLINE VISUAL AND INTERACTIVE TECHNOLOGICAL TOOL (OVITT) ON EARLY ADOLESCENT STUDENTS' MATHEMATICS PERFORMANCE, MATH ANXIETY AND ATTITUDES TOWARD MATH

DECEMBER 2013

This study reported the results of a 3-month quasi-experimental study that determined the effectiveness of an online visual and interactive technological tool on sixth grade students' mathematics performance, math anxiety and attitudes towards math. There were 155 sixth grade students from a middle school in the North Texas area who participated in the study receiving pretests and posttests on their math performance, math anxiety, and attitudes toward math.

The Demographic Information Form was given to parents along with a consent form to gather information on the parents' and students' families. The 2009 Texas Assessment of Knowledge and Skills (TAKS) test was used to measure students' math performance. The Math Anxiety Scale-Revised (MAS-R) and Attitudes Towards Math Inventory (ATMI) were used to measure students' math anxiety and attitudes toward math respectively. Questions about Brainingcamp, an educational math software for 6^{th} through 8^{th} grade students, were given to the experimental group to gather information on their computer use and about their belief about the help provided from the program.

Brainingcamp is an online, visual and interactive technological tool that provides visual lessons, interactive virtual manipulatives, and other ways to help students to understand abstract concepts in a more concrete manner. The research found that there were no statistically significant differences between the experimental and control groups, but there were improvements within both groups on their math performance from pretest to posttest.

Furthermore, this research found a statistically significant difference between the experimental and control groups on their math anxiety. The results also revealed that all students decreased on their self-confidence and motivation in math. However, the female students in the experimental group increased on their value of math while the males in both groups had a slight increase on their enjoyment of math. Based on ethnicity, White and Other (comprised of American Indian or Alaska Native, Asian, Native Hawaiian or Other Pacific Islander, Biracial, and Other ethnic groups) students increased on their enjoyment of math in the experimental group and Black and Other students increased on their enjoyment of math in the control group. Mothers' level of education was also examined and the results showed that the students' mothers' educational level was not a significant predictor.

The findings of the study are important to provide parents, teacher educators, and school administrators information to consider regarding the effects of online visual and interactive technological tools on students' math performance, math anxiety, and attitudes toward math because computer programs used in the classroom provide children the

interaction needed to connect to their real life experiences (Woolfolk & Perry, 2012). In addition, teacher educators and school administrators may want to use online visual and interactive technological tools as a scaffolding tool in addition to the common instructional methods used in the math classroom.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Students' math achievement levels in the United States are not as high as they were in the past (Nugent, Kunz, Rilett, & Jones, 2010) and currently other countries, such as Japan, continue to outperform students in the U.S. (Lee & Fish, 2010). The United States ranks 32nd based on the Program for International Student Assessment (PISA), with the Class of 2011 having a 32% proficiency in math (Peterson, Woesmann, Hanushek, & Lastra-Anadon, 2011). Unfortunately, 22 other countries outperformed the United States in math proficiency. For example, Korea had 58% of the students' in Korea were proficient in math. Even within the U.S., few states scored above 40% in math proficiency with some states scoring 30% and below (Peterson et al., 2011).

The National Council of Teachers of Mathematics (NCTM, 2012) has principles and standards for school mathematics that are essential for students in the United States and society as a whole. The NCTM states that the expectations for what students are to learn and understand fall under six standards: Number and Operations, Algebra, Geometry, Measurement, Data Analysis and Probability, and Process (NCTM, 2012). Within these six standards, the Process standard is to be embedded throughout all the other standards. These standards describe the expectations per grade level. There are also overarching themes that are to be addressed in mathematics, these are: equity, curriculum, teaching, learning, assessment, and technology. The standards must be aligned with all instructional facets such as teaching, learning, and assessment to ensure that the students receive effective math instruction to support their learning (NCTM, 2012). Additionally, the technology strand is important within teaching mathematics because it can be imbedded with the curriculum to provide students with active engagement and interaction within their learning. For example, technology can be utilized effectively as a scaffolding assessment tool in the math classroom (Bottge, Rueda, Kwon, Grant, & LaRoque, 2009; Koedinger, McLaughlin, & Heffernan, 2010).

The Texas Essential Knowledge and Skills (TEKS) and NCTM principles and standards provide an outline and expectations for student learning in math. In addition, there is a push for students to be able to think more critically and use problem-solving skills as a means of understanding the content and process of mathematics. However, many students continue to have difficulty with problem solving situations in mathematics. In this context, math performance refers to a student’s ability to display proficiency in math through the application of the content in various situations analytically and in real world situations (National Center for Education Statistics, 2009). It consists of math basic skills such as adding, subtracting, multiplying, dividing, ordering and comparing rational numbers (whole numbers, decimals, fractions, and percents). In addition to the basic math skills, math performance includes problem solving. Math problem solving is engagement in a math task, using various strategies and thought processes that have been learned throughout a student’s academic career in order to solve math problems of various types and levels (NCTM, 2012; Schoenfeld, 1992). Without students having basic math and problem solving knowledge and skills, students will not be adequately functional in their academics and may not be able to pursue certain careers in the science, technology, engineering, and mathematics (STEM) fields (Nugent et al., 2010). Also, those students are less likely to be competitive in the world economy or find jobs in cutting edge industries (Brogan, 2010).

In a global economy and technological world, technical skills become vital (Greenwood & North, 1999). Math knowledge is critical for a society to continue to grow and develop, especially in the area of research and development (Gutstein, 2007). Mathematics is a content area that can be transferred into daily life situations because within math students learn how to think critically while reasoning and solving problems (Terrell, 2007). Both of these thought processes require step-by-step planning and organization to solve a task. In addition, many careers require some level of math skills (Boaler, 2008; Schoenfeld, 2002). Students who can successfully learn how to think on a higher level are better able to transfer their problem solving skills to other areas in life (Boaler, 2008; U.S. Department of Education, 2009). Also, students who are proficient in math have the opportunity to acquire various types of high paying jobs because they have the necessary skills. However, the importance of math begins in the earlier years of education (Terrell, 2007). With a strong foundation in math, students can continue to build upon their skills in math no matter the difficulty of the new math information they are learning (Terrell, 2007).

In order for students to have a future influence on the global economy, more information is needed to illuminate the reason behind students' continued struggles in math. Some research has found various factors that are known to affect students' learning and math performance such as demographic characteristics (Lee & Bowen, 2006; Lubienski, 2000), level of parental involvement (Anderson & Minke, 2007), classroom environment (Clarke, 1997), instructional strategies (Butler, Beckingham, & Novak Lauscher, 2005; Clarke, 1997; Lubienski, 2000), students' math anxiety (Ashcraft, 2002; Ma, 1999; Newstead, 1998), students' attitudes and perceptions (Ellis & Berry, 2005; Ladson-Billings, 1997). However, there has been a recent focus on students' problem solving skills as a major factor affecting their math performance (NCTM, 2012). Some researchers maintain that math problem solving is the key component affecting students' advancement in math (Fan & Zhu, 2007; Ginsburg, Jacobs, & Lopez, 1993; Montague & van Garderen, 2003; Villa, 2008) while other researchers provide support that the use of different instructional methods, such as computer-based technology programs, motivate students to learn math and highly impact students' math achievement (Kanning, 1994; NCTM, 2012; Orabuchi, 1992; Suh, 2010).

There has been a plethora of research conducted over time showing the trends in academic achievement between some African American/Black and Hispanic students and their White counterparts. Several studies spanning over the past two decades (i.e., Entwisle & Alexander, 1990; Haycock, 2001; Johnson & Kritsonis, 2006; Lee, 2002; Malloy, 1998; Tate, 1997) have shown a consistently large achievement gap between

White and Black students, as well as between White and Hispanic students. The achievement gap is most prevalent in math (Ladson-Billings, 1997; Tate, 1997). African American and Hispanic students have been the lowest performing ethnic groups, as reflected by their math scores (Ladson-Billings, 1997). Although there have been some gains made, they have been minimal. The gains have been in basic math skills which do not show full mastery of the content (Johnson & Kritsonis, 2006). In addition, it has been noted there are gaps within gender as well; (Collis, 1987; Else-Quest, Hyde, & Linn, 2010; Middleton & Spanias, 1999), therefore, it is imperative to investigate these areas of concern to understand the effect they have on students' math performance.

The No Child Left Behind Act of 2001 is one of the leading acts of accountability in education in which schools are held accountable for teaching all students the national standards in mathematics (Cushner, McClelland, & Safford, 2006). Some children have difficulty mastering all the math standards due to past experiences with math. When students are unable to master the math standards, reasons behind it must be considered, as well as other possible instructional strategies that can be utilized to enhance the students' math learning. Thus, it becomes much more imperative to understand some of the reasons behind students' struggles in math.

There has been a surplus of research conducted to provide insight into possible reasons for students' struggle in math. Researchers have discussed students' math anxiety (Ma, 1999; Meadows, 2006; Newstead, 1998) and math attitudes/perceptions (Middleton & Spanias, 1999) as influences affecting students' math performance and math achievement. Math anxiety research has been limited to high school students, however, elementary and middle school students struggle with math anxiety as well (Newstead, 1998). Math anxiety is often considered to be a combination of tension and anxious feelings that interfere with a person being able to solve mathematical problems in various situations (Khatoon & Mahmood, 2010). A number of children develop negative feelings and higher levels of anxiety towards math that create a negative relationship with this subject area, thus negatively impacting their academic achievement (Newstead, 1998). The reason behind this may pertain to their past experiences with math. For example, a student who has had continued difficulty with math may not enjoy learning about it.

The self-efficacy of a child is influential on their math performance because the way students perceive themselves can have lasting positive or negative outcomes in their lives. When children have a low level of connectedness with learning math concepts and process skills they become less motivated and develop negative perceptions of their abilities (Collis, 1987). Graham, Taylor, and Hudley (1998) examined middle school students' achievement values and students' beliefs and motivation of their success in school, through the use of peer nomination procedures. Students' beliefs in their ability are often influenced by their perceptions of themselves and others (Graham, Taylor, & Hudley 1998). African American and Hispanic students tended to place low value on their academic achievement (Graham, Taylor, & Hudley 1998). In some cases, it is not about the student's ability, but the student's perceptions and efforts to be successful in their academics particularly in mathematics.

Statement of the Problem

Math is often seen as a subject that is difficult to master (Lubienski, 2000). Students begin to have an increased difficulty as they transition from elementary to middle school (Deslandes & Bertrand, 2005; Grover, Ginsburg, & Ialongo, 2005). The rigor in math increases as well as a change in structure and class time (Newstead, 1998). The foundational math concepts and process skills are vital learning tools as well as prerequisites for students to be functional enough to pursue careers in fields such as engineering and science. For students to be efficient and contributing productive adults in the work-force, they need to master math basic and problem solving skills in the classroom (Terrell, 2007).

There is a collective efficacy in students' academic achievement (Hoy, Tarter, & Hoy, 2006). The academic achievement of students in math continues to be a concern for teachers, school administrators, parents, and for some the students themselves. In order to solve this academic problem, one must be aware of the various factors that affect student achievement in math. Dewey believed that many of the problems we have in society do not stand alone, yet they are jumbled together (Diesing, 1991). This may be applied to students' academic achievement in math because that is a continued focus in all grade levels. Students are tested on national math standards every year in the U.S. This yearly testing typically occurs in elementary through high school grades. Some states, such as in Texas, begin state testing on students' mastery of the national standards in third grade (Texas Education Agency, 2011) while most states begin testing students in the first grade using the Iowa Test of Basic Skills (ITBS). Math and reading are the only two content areas tested at every grade level in Texas (Texas Education Agency, 2011). The main focus of the state tests is to show students' mastery of math concepts and process skills for the grade level based on the aligned national and state standards (NCTM, 2012). Furthermore, standards such as the Common Core State Standards, a group of standards which focus on college and career readiness, have been implemented in 47 of the 50 states (Rothman, 2012). The focus of Common Core State Standards for Mathematics is to ensure the instruction is aligned with the content that should be taught. In addition, there has been an increase of the use of technology in the workplace that requires more emphasis on problem solving (Rothman, 2012). Problem solving is a consistent problem for lower math performance in the U.S., especially among African American and Hispanics students (Lee, 2002). Sometimes this problem is due to a low level of rigor within their math problem solving, such as a lack of various strategies and thought processes needed to solve math problems of different types and levels (Lubienski, 2002). In order to help all students become better critical thinkers and apply their math skills in daily life successfully, it is important for students to receive tools and strategies that can develop and enhance those skills.

Purpose of the Study

The transition from elementary to middle school is a critical change in students' academic career (Schielack & Seely, 2010). They transition from learning the foundational aspects of their basic math skills and problem solving skills to more complex aspects of math in elementary school compared to middle school. The results of the Third International Mathematics and Science Study (TIMSS) revealed that students in the United States are not able to compete with other countries and middle school students perform very poorly (Arroyo, Royer, & Woolf, 2011).

There is a substantial amount of literature on other factors, such as students' demographic characteristics and students' parental involvement, that influence students' math performance (Turney & Kao, 2009); however, there is little information available regarding the influence of online computer programs and tools. Research has shown that students' reading performance increased based on the effects of a technological program (Forster & Souvignier, 2011; McClanahan, Williams, Kennedy &Tate, 2012). However, there is a gap in the literature regarding online, visual technological programs' effects on middle school students, specifically 6^{th} grade students' achievement in math. In addition, there is not a substantial amount of research on how technological programs help improve students' math performance, specifically in African-American and Hispanic students. When students have multiple forms to communicate within their learning, such as the use of computers, videos, music, etc., it allows the student to be an active participant in their learning (Kanning, 1994).

Evidence has shown that the use of computers aids in students improvement in comprehension in math and other contents (Moss, 2004; Project Tomorrow, 2011). Orabuchi (1992) investigated the effectiveness of interactive computer programs with first and second graders' overall academic achievement in math and reading. The results suggested that computer assisted instruction (CAI) is effective in teaching critical thinking and problem solving skills, a developmentally appropriate tool for students to use, and it was more effective in the improvement of the affective domains as opposed to the cognitive domains. Students had increased positive attitudes towards their experiences with the computers as well as school as a whole (Orabuchi, 1992). Nonetheless, there has not been a substantial amount of research that has investigated the effects of computer assisted instruction or technological programs with 6^{th} grade students in math. Therefore, the purpose of the study is to investigate whether the use of an online visual and interactive technological tool could be utilized in the 6th grade classroom to increase students' math performance in conjunction with reducing students' math anxiety and increasing their positive attitudes/perceptions of math.

Theoretical Framework

This study is based on Bandura's theory of Self-Efficacy, Piaget's Cognitive Development Theory, and Vygotsky's Sociocultural Theory. Bandura's theory of Self-Efficacy applies to students' beliefs about their own abilities and may provide an effective lens through which to understand math achievement (Bandura, 1977). Piaget's cognitive development can be applied to understanding how students' acquire the cognitive skills necessary to perform mathematical tasks (Piaget, 1968). Additionally, Vygotsky's Learning Theory provides a way to understand children's learning in regards to the zone of proximal development (ZPD) and scaffolding (Vygotsky, 1978).

Importance of Study

A limited amount of research is present on technology and the effects it has on 6th grade students' math achievement. This study provided some evidence of the effectiveness of using online, visual technological tools and programs to improve 6th grade students' math achievement and performance, particularly among African American and Hispanic students. In addition, this study investigated the effectiveness on 6th grade students' math anxiety and math attitudes/perceptions. It may also provide more insight for more research to be conducted on the impacts of technology on math achievement and performance, math anxiety, and math attitudes/perceptions of in 6th grade students.

Research Questions and Hypotheses

The following questions guided the study:

Q1: Will there be group differences between the experimental and control groups' math performance based on the use of an online visual and interactive technological learning tool?

It was hypothesized that there would be statistically significant differences in the math performance scores between the students that received the OVITT designed to provide students' rigorous learning through interaction and engagement for the time frame of three months and the students who did not receive the OVITT, as measured by the 2009 released 6th Grade Math TAKS test.

Q2: Will there be group differences between the experimental and control groups' math anxiety?

It was hypothesized that students who received the OVITT would have decreased math anxiety compared to the students who did not receive the OVITT, as measured by the Math Anxiety Scale-Revised.

Q3: Will there be group differences between the experimental and control groups' attitudes toward math?

It was hypothesized that students who received the OVITT would have more positive attitudes toward math compared to the students who did not receive the OVITT, as measured by the Attitudes Towards Math Inventory.

Q4: Will there be differences between experimental and control groups in math performance, math anxiety, and math attitudes compared by gender, ethnicity, and parents' education?

a) It was hypothesized that boys would score higher, white students would score higher, and students with more educated parents would score higher on the 2009 released 6th Grade Math TAKS test.

b) It was hypothesized that there would be no significant group differences on the Math Anxiety Scale-Revised and Attitudes Towards Math Inventory when compared by ethnicity and parents' education.

c) It was hypothesized that girls would score higher on the Math Anxiety Scale-Revised and would score lower on the Attitudes Towards Math Inventory.

Definition of Terms

The researcher used various resources to define the following terms below:

1. *Accommodation*- children's ability to change their schema based on the new information (Piaget, 1968).
2. *Adaptation*- children's ability to flourish in their environment with the accommodation and assimilation of new information (Piaget, 1968).
3. *Assimilation*-children's ability to process the new information learned into their existing schema (Piaget, 1968).
4. *Brainingcamp*- is an online visual and interactive technological tool that provides visual lessons, interactive virtual manipulatives, automated student assessment, fun real world problem solving, and correlates with various state standards (Brainingcamp, 2010).
5. *Demographic characteristics*- the students' information regarding gender, race/ethnicity, and socio-economic status (SES) (Pearson Education, 2003).
6. *Foundation*-basis/groundwork of something (*Merriam-Webster.com*, 2012), fundamental concepts
7. *Interactive*-students' engagement and involvement through communication and collaboration with other people or things (*Interactive*, 2007, para. 1).

8. *Math achievement*- mastery or high level completion of the specific grade math content based on the students' demonstration of the knowledge and skills on the national and state mathematics standards (Algarabel & Dasi, 2001; NCTM, 2012).
9. *Math anxiety*- "Mathematics anxiety is a feeling of tension and anxiety that interferes with the 'manipulation of mathematical' problems in varied situations" (Khatoon & Mahmood, 2010, p. 75).
10. *Math attitudes*-"general emotional disposition toward the school subject of mathematics" (Haladyna, Shaughnessy, & Shaughnessy, 1983, p. 20).
11. *Math performance*- a student's ability to display proficiency of math through the application of the content in various situations such as analytically and in the real world (National Center for Education Statistics, 2009).
12. *Math problem solving*- engagement in a math task, using various strategies and thought processes that have been learned throughout a student's academic career in order to solve math problems of various types and levels (Schoenfeld, 1992; NCTM, 2012).
13. *Math self-perceptions*- the way a person views themselves based on their math learning and experience.
14. *Online*-a person being connected to the internet.
15. *Scaffolding*- adult assistance given to a child through conversation and interaction of capable members within the same culture functions (Woolfolk & Perry, 2012).
16. *Schema*- a child's knowledge and process of acquiring knowledge (Piaget, 1968).

17. *Self-efficacy*- the belief a person has of their ability to achieve and complete a goal or task (Bandura, 1977).
18. *Struggle*- a student's difficulty in math; the student is unable to show understanding of math content skills and problem solving proficiently.
19. *Zone of Proximal Development*- is the "distance between actual development level and level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p.33).

Limitations

This study examined the effects of an online and interactive technological tool on 6th grade students' math performance, math anxiety, and math attitudes/perceptions. The participants were limited to one grade level at one school in the North Texas area. The researcher is a teacher at the school and participated in the intervention. The students were randomly assigned to a 6th grade teacher, but once they were placed with a teacher the classes remained intact.

The 2009 6th Grade Math TAKS released questions were used to assess math performance: math basic and problem solving skills, as opposed to State of Texas Assessments of Academic Readiness (STAAR). The Texas Education Agency, TEA, releases full test items every three years. However, TAKS test items will no longer be released due to STAAR, the most recent state standardized test as of 2012. Moreover, the test question items were not released or available for STAAR at the time of the study.

Summary

Mathematics continues to be a difficult content to master for many children (Lubienski, 2000). However, middle school students continue to perform at low levels which could be due to multiple factors such as students' math anxiety and math attitudes and perceptions causing a negative self-efficacy. Additional instructional strategies have been suggested to help students improve in their math achievement and performance (Schoenfeld, 1992; NCTM, 2012). Research suggests the hypothesis that online, interactive and computer assisted technologies can positively affect students in their math achievement and performance, math anxiety, and math attitudes/perceptions. Meanwhile, there is limited research pertaining to 6^{th} grade students and math.

Previous research (i.e. Entwisle & Alexander, 1990; Lee 2002) has shown students of various ethnic backgrounds struggle in math. However, it is very prevalent among African American and Hispanic students (Ladson-Billings, 1997; Lee, 2002). Students in the U.S. are not performing on the same level as their counterparts in other countries (Schaub & Baker, 1991). It continues to become evident that changes must occur within students' learning. Therefore, the examination of the use of technology in 6^{th} grade math merits further study. The current study examined the effects of an online and interactive technological on 6th grade students' math performance, math anxiety, and math attitudes/perceptions.

CHAPTER II

REVIEW OF LITERATURE

Introduction

This chapter provides classic and contemporary literature to support the research purpose within this dissertation. The review discusses the importance of math in school and our developing world. It also discusses the importance of math, students' math achievement and performance in the U.S. compared with other countries as well as students' achievement of different groups such as gender, ethnicity/race, and socio-economic status. Research on students' math anxiety, attitudes and perceptions toward math, and the relationship impact technology has on students' math basic skills and math problem solving are also addressed. The review concludes with the importance of technology and its influence on classroom mathematics instruction. Below, the literature review begins with the theoretical framework as the foundational lens of the dissertation study.

Theoretical Framework

Self-efficacy is a person's belief of his or her ability to achieve and complete a goal or task (Bandura, 1977). There are four main constructs of self-efficacy: cognition, emotion, motivation, and selection (Bandura, 1997). The beliefs students have of themselves affects their performance. According to Bandura's Theory of Self-efficacy, there are two aspects of cognition in self-efficacy, cognitive constructs and inferential thinking (Bandura, 1997). Within cognitive constructs, there is a direct relationship between self-efficacy and academic achievement. According to this approach, the way students perceive themselves affects how they will succeed on various tasks. A sense of self-efficacy has effects on the motivation for students to do well. With inferential thinking, students are able to predict the outcome of a situation. For example, problem solving skills are essential skills to develop and use because they require a person to look at a situation from multiple standpoints and decipher the best process to reach the final and best solution with justification. This requires, however, that a person have a strong sense of self-efficacy in order to solve challenging problems in the classroom and in life (Bandura, 1997) without being afraid of making errors in the process. Mistakes will occur because they are a part of life, but the method of problem solving during demanding and ambiguous situations determines how it will affect the person's performance. Also, students who are not afraid of making mistakes while solving problems in the classroom seem to be more determined and motivated to finding solutions.

Motivational processes are rooted in how people view themselves (Bandura, 1997). Students who are able to relate their successes to their effort and relate their failures to a lack of effort are able to handle adversity in their performance, but the students who connect their failures to their inability and their successes to factors outside of themselves have a difficult time overcoming adverse situations (Bandura, 1997). This is an example of the attribution theory of motivation in action. The higher the level of self-efficacy a person has, there is a higher chance of the person succeeding. This theory is based on having a positive belief of one's ability and acknowledging that effort is required to reach the goals. This is also related to the expectancy-value theory, another motivational process where students expect a certain outcome based on a given behavior (Bandura, 1997).

Sometimes students expect to fail based on past experiences that affected them emotionally (Bandura, 1977). For example, some students have a negative emotional involvement in their math achievement, due to their past experiences with math, resulting in anxiety, or fear and avoidance (Bandura, 1997). Furthermore, a student's self-efficacy can influence the paths he or she takes in life. If a student feels incompetent in a content area, he or she is less likely to pursue a career path in that field or partake in careers that include the use of that content area. The selection process becomes important because if many students dislike math or feel unable to achieve in math, it can lead to fewer people in the fields of math, science, technology, and engineering. In order to change this negative mindset of students, there needs to be an understanding of students' perceptions of themselves to improve their performance.

According to Piaget's Theory of Cognitive Development, knowledge is an active process that the child is constantly improving with existing and new knowledge (Piaget, 1968). Furthermore, children's activity generates their thinking. Because of Piaget's focus on the language and thought process of children, he also believed that children's thinking is not about the correct answers, but about students' thought processes to arrive at their various answers (Ginsburg, Jacobs, & Lopez, 1993). Piaget's theory provides information on how the process of acquiring information is essential. Piaget (1968) stated that children have schemas, described as a child's knowledge and processes of acquiring knowledge. A child's schema can include his or her experiences, beliefs and perceptions, and information learned throughout their life. Children may process the new information learned into their existing schema (assimilation), change their schema based on the new information (accommodation), or adapt to flourish in their environment (Piaget, 1968).

Piaget believed children should be active participants in their learning throughout life (Piaget, 1959). There are four stages of development identified by Piaget (1968) that children progress through: Sensorimotor (birth-2 years), Preoperational (2-7 years), Concrete Operations (7-11 years), and Formal Operations (age 11-adulthood). Throughout each stage of development, the child is learning something new to add to schema. For example, the sensorimotor stage is when the child as a baby is learning movements such as making noises, grasping objects, coordination-learning to walk, recognizing the location of objects, and other reactions to experience the world around them (Piaget, 1968). Piaget felt those movements influenced cognition. The preoperational stage is a continuance of experiencing the world, but with a focus on symbolic thought and understanding of how words have meaning. During the concrete operational stage, children are learning how to better connect their words with meaning and learn concepts distinctively (Piaget, 1968), such as in math, using base ten blocks to understand place value. Children in this stage are beginning to think and reason logically, becoming less egocentric, and developing on a higher level based on the learning from the previous stages. As students enter the final stage, formal operations is considered to be a time period where children are transferring their concrete knowledge to the abstract level (Piaget, 1968). They are using and applying previous knowledge and experience on a higher level and thinking critically about the world around them.

Children within the ages of 11 to 15 should have a higher level of understanding of reason, transitioning from concrete to abstract thought (Piaget, 1972). Piaget also stated that children ages 7 to 10 can also have that ability, but it is not on the same level as older children. They can only apply their logical reasoning in certain situations. He continued by comparing the thought of both groups of children to physics. Piaget (1972) stated when children who are between the ages of 7 to 10 are presented with an experiment, laws that pertain to the swing of a pendulum, they will respond to the materials and test them out without thinking about the relationship of factors that relate to the experiment. On the other hand, children ages 11 to 15 will look beyond the materials. They will try similar strategies, but also go beyond basic steps and include hypothesizing results. Within Piaget's cognitive development theory, one can understand children's thought processes and how they are applied to academic achievement and performance. Concrete learning is essential in children's early development in order for children to apply the content knowledge abstractly. From a Vygotskian perspective, one understands cognitive development as more than the individual's mental ability, but rather a combination of cognition with their social context to facilitate learning development (Vygotsky, 1986).

Vygotsky's Learning Theory, specifically the zone of proximal development (ZPD), is an essential process in the cognitive development of children. The ZPD refers to the "distance between actual development level and level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 33). When children struggle in school, teachers or more capable peers can provide assistance to help the child reach their potential level on a task. An aspect of ZPD is scaffolding, the assistance children are provided by an adult through conversation and interaction (Vygotsky, 1978). The assistance could be in form of clear communication, collaboration with other students, teacher guidance, as well as engaging activities to create experiential opportunities for students to thrive in learning situations. When presented with opportunities, children extend their range of learning development and construct knowledge from their experiences (Lerman, 1996).

Communication, collaboration, guidance, and engaging activities are tools that function to improve the child's ability to reach their potential and perform higher level functions (Woolfolk & Perry, 2012). In keeping with Vygotsky's definition of scaffolding and connecting it to Woolfolk's and Perry's (2012) tools to improve children's ability to reach their potential, the use of online, visual interactive technological tools and programs could be viewed as an authentic utility for scaffolding. Although technology is not an adult or even human component, it still provides students assistance. The child is being taken from their current level to a higher level through interaction.

Students' problem solving processes can be explored so that teachers, parents, and others in the educational field can provide children with the necessary guidance to promote learning. From the development of thought and language, children are able to begin higher level thinking and internalization. Vygotsky's theory provided that the external world influenced the understanding and knowledge of a child (Vygotsky, 1978). Woolfolk and Perry (2012) stated that "reasoning and problem solving are mediated by language and symbols" (p. 51). Activities, such as computer programs, can serve as mediators to provide children a way to interact with their environment (Woolfolk & Perry, 2012). If the child is limited in resources, for example to one instructional method, it may limit opportunities for the child to problem solve.

Importance of Math

Some students often wonder if math will ever be used outside the four walls of their math classroom. It becomes difficult for some students to see the importance of math in school and beyond for multiple reasons. Examples include the complexity and difficulty to see a direct connection to other content areas and daily life (Boaler, 2008) may further blur students' concept of math in their lives. When students begin to see the usefulness of math, they will be able to build on their knowledge and skills as well as pursue more lucrative careers that include the use of math. Therefore, math is significant in its early learning and foundation and its use in multiple professions (Boaler, 2008;

Nugent, Kunz, Rilett, & Jones, 2010; Peter, Glück, & Beiglböck, 2010; Schoenfeld, 2002; U.S. Department of Education, 2009).

Foundational Level

In order for students to attain the level of applying math fluently outside of the classroom, students must have the necessary foundation of basic math skills (Jordan, Kaplan, Ramineni, & Locuniak, 2009). According to Peter, Glück, and Beiglböck (2010), in order for children to reach the final stage of Piaget's cognitive development successfully, they should have constant practice of learning and engaging experiences from the previous stages of development. The preschool and elementary years are foundational years for learning math (Jordan et al., 2009). Some children often dislike math because a solid foundation using concrete materials was not established in the preoperational stage of development. Students begin to learn about numbers, their operations, and their relationships during their early schooling (Jordan et al., 2009). Basic whole number competencies are a recognized weakness in math during the elementary years (Jordan et al., 2009). For example, students begin to add, subtract, multiply, and divide whole numbers in elementary school. If they are unable to master that concept or skill in elementary school, as they enter middle school, the students may continue to struggle to apply addition and subtraction concepts to decimals and fractions accurately. Thus, it becomes vital to correct any weaknesses in math because it can develop into a weak foundation that carries into the next grade level with increased math difficultly

(Jordan et al., 2009). Without the basic math skills, students will have difficulties applying the new math topics to the information they are expected to know.

In a 2008 article, Chard et al. discussed how the U.S. has reported poor math achievement over the last decade. Moreover, low achievement in math may be due to a lack of rigor in early instruction and curriculum. Research has been conducted that shows how early number competence is a predictor of students' math performance in school (Jordan et al., 2009). Jordan, Kaplan, Olah, and Locuniak (2006) studied number sense development of 411 middle and low income kindergarten students. Number sense includes the areas of counting, number knowledge, number transformation, estimation, and number patterns (Jordan, Kaplan, Olah, & Locuniak, 2006). The kindergarten students received a number sense battery four times throughout the school year with a reading skills assessment on the fourth time. In addition to the number sense section, conventional arithmetic was included. Conventional arithmetic is the use of story problems and number patterns in math (Jordan, et al., 2006). This was part of a longitudinal study the researchers had been conducting over time.

The conventional growth curve modeling and growth mixture modeling were two statistical approaches that were utilized (Jordan et al., 2006). The conventional growth curve looked at the growth at a specific time and estimated growth over time for all the students. However, it was limited to assuming there was one average growth curve for the population (Jordan et al., 2006). Therefore, the growth curve modeling provided a way to look into "distinct trajectory classes" (Jordan et al., 2006, p. 156). A multinomial logistic regression was used to determine the probability of a student being assigned to a certain trajectory class such as male or female, low or middle income, good or poor reader, and started kindergarten earlier or later. Three classes were found pertaining to average: low, median, high and growth rate: flat, moderate, steep growth based on their exit level of their overall number sense battery (Jordan et al., 2006). A factor analyses was also used to show construct validity. In addition, the factor correlations were shown to be consistent over time (Jordan et al., 2006). There were three classes based on the kindergarteners' performance on nonverbal calculations: 44% ''low/flat'', 30% ''high/steep,'' and 26% ''high/mod'' and on story problems: 70% low/flat, 14% high/mod, and 16% high/flat. Students' performance on number combinations consisted of: 61% low/flat, 13% high/steep, and 26% high/mod different (Jordan et al., 2006).

There was overall growth, but mostly within number sense (Jordan et al., 2006). Low reading scores were prevalent amongst students who began kindergarten at an older age. Those same children were also from low income households. It was noted that the African American and Hispanic students were the majority of the low income students (Jordan et al., 2006). There were gender differences at the end showing male students doing better, but there were no statistically significant differences over time. Older children who began kindergarten were indistinctly advanced in number sense skills compared to the younger kindergarten students, but it was not significantly different (Jordan et al., 2006).

The researchers' work suggests that the reading proficiency is a predictor of math performance because many of the low-performing students had a weakness on the number tasks that included reading, for example, the story problems (Jordan et al., 2006). However, progress was made without the verbal language and use of visual representations on the number tasks. This further suggests that the importance of math is vital because it connects to students' verbal, spatial, and memory skills (Jordan et al., 2009). Questions were formulated at the end of the study to see if students' kindergarten number sense is a predictor of their achievement in elementary school and beyond.

Jordan et al. (2009) continued the longitudinal study to examine if early math was a predictor of future math achievement. This study was the final part of the Children's Math Project (Jordan et al., 2009). Kindergarten (N=378) and third grade (N=196) students from low and middle income schools in a Delaware school district participated. The researchers looked at the kindergarten students' number competence and the third grade students' mathematics achievement to show possible differences over time. Math Trailblazers curriculum was used with all students. It incorporated math and science concepts, while 15 of the participants used the Investigations in Number, Data, and Space curriculum during 2nd and 3rd grade (Jordan et al., 2009). The number competency core battery contained 42 items that pertained to counting and number recognition, number comparisons, nonverbal calculation, story problems, and number combinations (Jordan et al., 2009).

The participants received assessment eleven times between kindergarten and first grade (Jordan et al., 2009). The Calculation and Applied Problems were portions of the Woodcock–Johnson III that measured students' math achievement. The researchers noted that it correlated with the Delaware state testing program (Jordan et al., 2009). There was a limitation of losing participants over time; however, the researchers were able to see the effect early number competency has on later grades, especially with the next grade level (Jordan et al., 2009). The results provided information on the growth factors on the Number Competence and Woodcock–Johnson General Mathematics Achievement (WJMath). There was a positive association between number competence in kindergarten and in the WJMath in 3rd grade: the higher the number competence, the higher the WJMath (Jordan et al., 2009). Additionally, steeper growth from kindergarten to 1st grade resulted in a higher WJMath, as well as steeper growth between 1st and 3rd grade. Background variables such as income, gender, and kindergarten start age had an effect on students' performance on their number competency and WJMath (Jordan et al., 2009). Although there were no statistically significant differences within gender, there were some apparent differences with income and kindergarten start age. Students with a low income background had a low average performance number competency and also had low average growth, while younger children did not have a high average compared to the older children (Jordan et al., 2009).

In summary, the two studies presented above provided information regarding the effects children's early number competence have on their future math skills. The math learned in kindergarten and first grade are foundational concepts that support higher level math skills taught later (Jordan et al., 2009). Early number competencies in math are important because “understanding of numbers and number relations makes formal mathematics more accessible” (Jordan et al., 2009, p. 12). When students are able to grasp basic math concepts they can develop more than the basic math skills, but also reason with numbers and understand the relationship between numbers. This provides the beginning steps for problem solving. If students are without it, they enter the next grade level at a disadvantage constructing a continued trend of not knowing the necessary math skills for each grade level (Jordan et al., 2009).

Children experience the challenge of transition from elementary to middle school math such as changes in instructional methods and tools (Schielack & Seeley, 2010). The math becomes difficult because of the new concepts within the next grade level and if the student did not have the prior foundational math skills mastered. Another study looking into the importance of math at the foundational level was conducted by Mazzocco and Devlin (2008). Fractions and decimals are foundational math concepts for later grades (Mazzocco & Devlin, 2008). They are concepts that can be very difficult for middle school students to grasp, making it more difficult to determine if a student has a math learning disability (MLD) or not (Mazzocco & Devlin, 2008). The participants were from a longitudinal study of kindergarteners recruited from seven different schools in a suburban neighborhood area that included students who were free/reduced lunch and those who were not (Mazzocco & Devlin, 2008). This study included 147 of the 259 children who participated during the 6th through 8th grades (Mazzocco & Devlin, 2008). Students were categorized as MLD, low average math achievement (LA), and typical math achievement (TA) based on their Woodcock Johnson-Revised Calculations subtest (WJ-R-Calc) (Mazzocco & Devlin, 2008).

The students were individually tested during the spring semester of the three grade levels (6th, 7th, and 8th grade) with the Ranking Proportions Test (RPT) battery test (Mazzocco & Devlin, 2008). There was a warm-up trial, reading task, and four subtests included within the battery test. The students were to identify decimals, pictorial representations of fractions, fractions, and decimals and fractions mixed together (Mazzocco & Devlin, 2008). The participants were asked to order fractions and decimals along with name the largest and smallest decimals and fractions. In Subtest 1 regarding decimals (less than 1), students were to read the decimal aloud and if they read it incorrectly (i.e. '20' for '.20' or 'point two oh' for '.20') they were to reread it again. The researchers only coded the accurate set of responses (Mazzocco & Devlin, 2008). The researchers used a 3 (MLD, LA, and TA groups) X 4 (subtests) X 3 (grade levels) ANCOVA (Analysis of covariance) to analyze the accuracy ranking data with the IQ score (from the Wechsler Abbreviated Scale of Intelligence) used as the covariate. Mazzocco and Devlin (2008) found the higher the students' IQ tests and grade levels, the higher he or she scored on the accuracy rankings. There was variance throughout the subtests; however, Subtest #2 with the pictorial representations had the highest score compared to the other three subtests whereas Subtest #3 (fractions) and Subtest #4 (fractions and decimals) had the lowest scores. Children with MLD ranked lowest overall with LA and TA children not having much of a difference between one another on the subtests. Students in the LA and TA math achievement groups did not perform significantly greater on the pictorial subtest than the others as did the MLD group (Mazzocco & Devlin, 2008).

Mazzocco and Devlin (2008) also examined at the number of correct and incorrect ties, pairs of equal numbers (i.e. 0.50=50/100). A 3 X 4 X 3 ANCOVA was also used to analyze the ties. The results showed that children with MLD had the least amount of correct ties and there were no differences between the LA and TA group. There were major differences in 6th grade between MLD (50%) students and TA (10.5%) students on the number of incorrect ties (i.e. 0.50=5/100). On the other hand, the number of students with incorrect ties decreased in 8th grade for all students (Mazzocco & Devlin, 2008). The reading task pertaining to reading a decimal correctly resulted in a majority of the 6th grade students (76.4%) able to read it correctly, but the majority of the MLD group did not read it correctly. The researchers looked at 6th grade students' response time and self-corrections, but there were no effects based on the IQ of the students so it was not pursued.

The researchers examined rational numbers, a foundational concept in middle school and an extension of number sense in elementary math foundations. Students with MLD struggled throughout working with rational numbers (Mazzocco & Devlin, 2008). Although they were the group of students who had the most difficulty, the students with

LA in math did not show mastery on the RPT battery test. Many of those students failed the reading task significantly compared to their TA student counterparts (Mazzocco & Devlin, 2008). There was uncertainty as to the performance between the MLD and LA group because they both showed difficulties and failures, but in different ways. Both had a misunderstanding of recognizing that there are other place values aside from tenths and thousandths, but the LA group was able to rank fractions and decimals together (although incorrect the majority of the time). Fractions were the most difficult for all students. There was improvement in 8th grade, but a substantial number of students continued to struggle throughout all three grade levels. The researchers noted that the foundational aspect of fractions was learned in 6th grade. "Rational number sense is a prerequisite to computation with fractions" (Mazzocco & Devlin, 2008, p.690). If students are unable to grasp this math concept, they will continue to have difficulties when working with fractions and decimals on another level, such as adding and subtracting. The researchers recommended that the instructional method must be looked into to better help students on this concept that they struggle with throughout their middle school years (Mazzocco & Devlin, 2008).

Schneider, Grabner, and Paetsch (2009) used path models to compare the influence of the child's distance effect (mental number line), spatial-numerical association of response codes (SNARC) effect, conceptual knowledge about decimal fractions, and numerical intelligence on 5th and 6th grade students' their math achievement. The number line estimation with decimals and fractions was tested to see if it can be used as a mediating tool compared to the internal/mental number line. The mental number line is defined as the internal understanding that small numbers stay to the left and big numbers stay to the right. For example, children can eventually automatically know and understand that nine is more than five. The researchers refer to numerical intelligence is the students' ability to reason and think critically in solving complex problems in math. Schneider et al. (2009) found that there was no significance pertaining to distance and SNARC effects, but there were some with domain-specific conceptual knowledge.

There was a strong association with conceptual knowledge and math achievement (Schneider et al., 2009). The use of visual representations and complex ones are possible mediating tools. Higher level math understanding emerges from the basic math skills such as the use of the number line as a visual representation of number notations (Schneider et al., 2009). All students may not learn abstract concepts immediately. Students need their prior knowledge connected with conceptual and concrete understanding to successfully transfer into the abstract thinking (Schneider et al., 2009). With these skills strengthened in their elementary and middle school years, students can successfully build new knowledge consistently and into their adult lives.

Career Level

The majority of people in society assume math to be important, but it is often taken for granted (Stanic, 1989). With the new arrivals of various technologies, students must apply their mathematical reasoning to successfully work and live in today's society (Boaler, 2008; U.S. Department of Education, 2009). There are many job career opportunities in the STEM fields, but there are low percentages of qualified people for those jobs (Boaler, 2008; Schoenfeld, 2002). Every year there are changes and improvements that cause a continued increase of demands in the workforce (Nugent, Kunz, Rilett, & Jones, 2010). When students struggle in math it can create a negative relationship with their math achievement in school and future use of math (Newstead, 1998).

There have been many shortages in the STEM fields (Nugent et al., 2010). However, with better math knowledge, practice, and exposure to how these fields relate to math content in the classroom, students can become well equipped adults in the STEM fields (Terrell, 2007). Brown, Brown, Reardon, and Merrill (2011) conducted a study with 27 college students enrolled in the STEM Education and Leadership program at Illinois State University. The students were to solve the questions based on their knowledge of the meaning and importance of STEM. In addition, 200 teachers and administrators were interviewed and completed surveys (Brown et al., 2011). The findings provided information regarding the teachers' and administrators' understanding of STEM education with only half of the participants able to define it adequately. In addition, 75% of the participants believed STEM education to be important because it bridges disciplines, teaches problem solving skills, and provides the cognitive development skills needed for students to see the connection between the science, technology, engineering, and math (STEM) fields. Although there was not a clear definition of the STEM from the participants in the study, it is clear that STEM fields are important in multiple ways (Brown et al., 2011). The researchers noted that further research must be conducted to examine and discuss implementation of a STEM program.

In order to address the shortage in STEM career fields and examine the implementation of a STEM program, the faculty of College of Engineering and Technology and the College of Education and Human Sciences at the University of Nebraska-Lincoln (UNL) worked together to provide a professional development for middle school and high school math and science teachers known as The Nebraska Project (Nugent et al., 2010). There were summer engineering camps for the students, but the main focus was to impact teachers so they can do the same for their own students (Nugent et al., 2010). They wanted the teachers to be exposed to STEM field careers, in this situation engineering. The teachers solved various problems, related their learning to math and science, and transferred the information to align with the standards to teach their students (Nugent et al., 2010). This was an avenue for teachers to receive direct experience of the use of math and science content in real world jobs. For example, there were two middle school math teachers who were able to connect the middle school math topics of data collection, measurement, ratios and proportions, etc. to engineering transportation problems (Nugent et al., 2010). The students were able to participate in the activity to understand traffic flow and other transportation issues that occur in real life.

Project Impact was a research project organized to assess the impact of the professional development of the teachers and the impact of the lessons on the students that occurred over a period of two years of the program (Nugent et al., 2010). There were pre-tests and posttests to assess the teachers' engineering knowledge, which showed improvement during the two year span. The teacher participants also noted that their increased knowledge could help them in teaching fundamental and advanced math and science concepts in the classroom (Nugent et al., 2010). The teachers' technology skills and confidence increased to the level of being able to incorporate technology effectively in the classroom (Nugent et al., 2010). In regards to student impact, teachers expressed that the program helped their students in the classroom. The teachers stated that 80% of their students met the standards and beyond for the lessons (Nugent et al., 2010). Student feedback was also solicited. Eighty-six percent of the students stated they strongly felt that they learned from the lessons and 75% were engaged in the lessons throughout. Some student statements included: "We got to use computers and do hands-on work; learned stuff I didn't know before" and "I like that it's a lot easier to understand by putting the math to something that we see in real life" (Nugent et al., 2010, p. 18).

Throughout the study, the STEM careers were connected to the math classroom (Nugent et al., 2010). The importance of math was exemplified through the students' active participation with lessons that were supported by real world situations. Furthermore, the teachers' knowledge and experience played a role in the importance because they were better able to connect their program experience to the way they taught math and science to their students (Nugent et al., 2010). Students who are engaged in math, no matter their struggle, can become successful in the STEM fields, but it requires getting students to want to pursue these fields at an early age (Terrell, 2007). When there are more students pursuing the STEM fields, there is more prosperity that can be brought into the nation (Thomasian, 2011). There would be more constructions of highways and buildings, new developments in medicine and technology, as well as other developments that would better the world. As a result, children need adequate preparation to be the future leaders who can be successful participants in the workforce.

Math in the United States Verses Other Countries

From a Kuhnian (1970) perspective, the United States is currently in a crisis as it pertains to mathematics education. Many people in the U.S. are not prepared in the highly skilled fields such as science, technology, engineering, and math as they were in the past (Ladson-Billings, 1997; Nugent et al., 2010). Currently, the U.S. lags behind many other countries when it comes to achievement in math and science based on the Trends in International Science and Math Study (TIMSS) conducted in 46 countries. Other countries continue to increase on the number of people who graduate in these fields (Nugent et al., 2010; Porter, McMaken, Hwang, & Yang, 2011; Rothman, 2012). In order for students to be attracted to these fields and for the U.S. to improve in this area, the preparation must begin in primary and secondary schooling (Nugent et al., 2010).

Math Achievement among Different Countries

The 2003 and 2007 Trends in International Math and Science Study (TIMSS) investigated comparisons of math assessments of 4^{th} and 8^{th} grade students. There were 17 countries that participated in addition to the U.S., such as Canada, England, the Czech Republic, Italy, Netherlands, Australia, Iran, and many Asian countries including Korea, Japan, Hong Kong, and the Chinese Taipei (Lee & Fish, 2010). The results showed the U.S. 4^{th} and 8^{th} grade students' scores to be above the international average, yet far behind the Asian countries. In addition, based on the countries that participated in the 1995 fourth-grade TIMSS and 1999 eighth-grade TIMSS, the U.S. and the Czech Republic, Italy, and Netherlands were the only countries that dropped in performance from 4^{th} grade to 8^{th} grade compared to the other countries that either maintained their performance level or increased it greatly (Lee & Fish, 2010). The posed questions were: why is there a large achievement gap from 4^{th} to 8^{th} grade in the United States? Why are students not performing at a high level in math as their counterparts in other countries?

Lee and Fish (2010) examined these differences by looking into the variations within the nation and states of growth in the average math achievement of 4^{th} and 8^{th} grade students. The sample consisted of repeated cross-sectional data from the TIMSS 1995 fourth-grade and 1999 eighth-grade math assessment data and National Assessment of Educational Progress (NAEP) 1996 fourth-grade and 2000 eighth-grade mathematics data samples. The researchers looked at the total achievement gains from 4^{th} to 8^{th} grade based on age, the combination of entrance age and the age at the time of the test, and grade level (Lee & Fish, 2010). Six countries were included in this study from the international data (Canada, Cyprus, Czech Republic, Japan, Korea, Singapore) because they participated in the TIMSS and had birth date information for the students. For the comparison among states, there were 28 states used because they participated in the NAEP and had an enrollment age of 5 in kindergarten as the cut-off age.

The following states were:

> Alabama, Arizona, Arkansas, California, Connecticut, Georgia, Hawaii, Kentucky, Maine, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Mexico, New York, North Carolina, North Dakota, Oregon, Rhode Island, South Carolina, Tennessee, Texas, Virginia, West Virginia, and Wyoming (Lee & Fish, 2010, p. 116).

The sample included a total of 193,086 students with 101,835 4th graders and 91,251 8th graders (Lee & Fish, 2010). The researchers used hierarchical linear models (HLMs) to study variations of math achievements within the nation/state and between the nation/state based on the TIMSS and NAEP samples (Lee & Fish, 2010). The pace of growth within states was based on the gains from the NAEP data due to the U.S. not having a national standard math achievement test (states have their own standardized test that correlates with the national standards). The socio-economic status was included based on available information of the parents' income and educational level (Lee & Fish, 2010). In reference to comparisons with other countries, an HLM analysis was used in conjunction with a coefficient model with the age and grade level to compare variations of math achievement.

Students improved on their math achievement from 4th grade to 8th grade (Lee & Fish, 2010). Based on independent t-tests to look for differences, SES was not a factor overall. The average gain among the six countries and within the U.S. was 57 points. However, there were differences within the states. For example, students in Mississippi had an average gain of 45 points, while students in Montana had an average gain of 60 points (Lee & Fish, 2010). The researchers stated that all of the 28 states were behind many of the TIMSS countries in average math achievement gains. Fifty points was the average math gain in the U.S. while the three East Asian countries Japan, Korea, and Singapore had an average math gain of 65 points. The researchers noted that it was equivalent to being a year behind in learning (Lee & Fish, 2010). The age effect varied throughout, but for every month, the child is expected to gain 60 points. There were no statistical differences in age and grade effects with the U.S. and non-East Asian countries, but there were major grade effects with the U.S. and East Asian countries. This difference depended on grouping and the fast-track programs students were taking.

The grade level effect was significant for math achievement with school year length and parent education (Lee & Fish, 2010). This difference provides information on the importance of parental involvement and engagement of their child's education within the U.S., but it does not provide information regarding the large gap between the U.S. and other countries. There is a slower growth in the U.S. during the middle school years in math. Increasing the rigor in national standards has been a suggested solution to help close the math achievement gap (Lee & Fish, 2010).

To further investigate the international differences in math achievement, an earlier study by Schaub and Baker (1991) examined math achievement between American and Japanese students in the middle grades (age 13). In addition, they hypothesized that teaching and non- teaching tasks have an impact on students' math achievement, specifically instructional methods (Schaub & Baker, 1991). The researchers used multistage, stratified, probability sampling to ensure comparable groups. Both countries were guided by the International Association for Educational Achievement (IEA) National Center and the IEA International Mathematics Committee to further ensure that the groups were comparable (Schaub & Baker, 1991). The American 8th graders (6,500) were compared to the Japanese's 7th graders (8,000) because they were comparable groups based on standardized testing. Teachers were also involved in the study (Schaub & Baker, 1991).

The students took a 60 item, multiple choice pre- and posttest, at the beginning and end of the year on mathematical knowledge and skills (Schaub & Baker, 1991). Teachers were posed questions at the end of the year on the instructional methods, teaching and nonteaching tasks, and classroom management. The results provided information on the differences of math achievement based on the national differences in math, dimensions of classroom achievement, and class time and instructional methods. Based on the tests, Japanese students showed an average gain of 20 points from the pretest to posttest. At the same time, Japanese students begin the school year knowing 40% of the material compared to Americans knowing 23% (Schaub & Baker, 1991). A regression analysis was used to discover the dimensions of classroom achievement in math. The findings showed that students' prior knowledge and students' variance of knowledge play a vital role in classroom achievement. They are important findings because they can cause barriers within teaching such as more time being spent on reteaching concepts students should already know (Schaub & Baker, 1991). Furthermore, if the variance can be reduced throughout the year, there would be a higher classroom achievement. Students' incoming knowledge and student involvement are essential components for learning. Japanese students' learning gaps are more easily reduced in comparison with American students. However, there are still questions as to why this difference occurs.

Schaub and Baker (1991) believed the management of class time and instructional methods were possible predictors of students' learning. The results showed that American teachers spent more time on non-teaching tasks such as keeping order and classroom management. American teachers also prepared less and reviewed older material as opposed to Japanese teachers who spent more time on new material. However, the differences were not statistically significant (Schaub & Baker, 1991). Japanese teachers used more whole class instruction than American teachers, who used a wide array of methods (small group, individual work, think-pair-share, etc.). However, the researchers noted not one method prevails over the other because whole class may be more efficient for the Japanese classroom because there are fewer variations of students' incoming math knowledge and skills. Students' incoming knowledge can be a barrier on their achievement due to the varying levels of knowledge they have. Although this variation is apparent, Japanese teachers teach to the whole class. On the other hand, this type of instruction is not sufficient for students within the U.S. educational system because of diverse backgrounds and learning styles (Smith, Desimone, Ueno, 2005). Therefore investigating comparisons of teaching methods of the U.S. and other countries could provide information of the international differences of math achievement. Different methods of instruction emerged in Schaub and Baker's (2001) study suggested further investigations.

Math Instructional Methods among Different Countries

Much of math teaching has focused on basic skills, step-by-step working through of word problems and other methods. Some teachers use the procedural teaching strategy rather than conceptual. This method does not provide students with the various instructional methods needed to internalize information and make connections with the math they are learning to their daily lives (Eisenhart et al, 1993). Butler et al. (2005) stated that researchers have highlighted developing students' conceptual knowledge in math so they may become problem solvers in math and extend it to their lives.

Conceptual Learning

Smith, Desimone, and Ueno (2005) studied the possible correlation of educational credentials, preparedness to teach content, participation in professional development, and instructional methods of middle school math teachers. The researchers used a stratified probability sample of 16,000 8th grade students and their math teachers from 744 schools in the United States. The data was derived from the 2000 National Assessment of Educational Progress (NAEP). There has been an emphasis for teachers to focus on conceptual teaching strategies rather than memorization and other traditional procedural methods of the past (Smith et al., 2005). In high achieving countries such as Japan and

Singapore, the use of conceptual teaching strategies has provided students the ability to be active thinkers and problem solve through investigations, making predictions on problems without obvious solutions rather than trying to rely on memorization or procedural strategies (Smith et al., 2005).

The researchers gathered information on the teachers' race/ethnicity, years of teaching math, certification (certified or not and type of certification-math specific or general), degree (bachelor, masters, etc.), preparedness (how comfortable and knowledgeable of teaching various concepts in math), professional development, school type (public, private, etc.), and SES of the school. These variables are known to be effective predictors of a teacher's teaching practices (Smith et al., 2005). A hierarchical linear model was used to predict the focus on the relationship between credentials and teaching experience, as well as the role preparedness and professional development played in the relationship (Smith et al., 2005). The results revealed that there was not a linear relationship between credentials and teaching experience because the teachers who had three to five years and more than 10 years used more conceptual teaching concepts than new teachers or those who taught 6-10 years. When the degree type or level was compared among the teachers, the results showed that they were not statistically significant. A likelihood ratio test was used to see if there was another relationship and the researchers found that having a graduate degree or having an undergraduate degree in math had a similar relationship with the emphasis of using conceptual strategies to teach math (Smith et al., 2005).

In summary, Smith et al (2005) concluded that having more professional development, more years of experience, and formal education more likely constitutes the use of using conceptual teaching strategies (Smith et al., 2005). Additionally, if a teacher felt more prepared and had an undergraduate degree, they were more likely to use procedural and conceptual teaching strategies. However, there were gaps with teachers who have degrees in math and do not, which makes a difference in their instructional methods (Smith et al., 2005).

Hiebert et al. (2005) used the Third International Mathematics and Science Study (TIMSS) 1999 Video Study that examined eighth-grade mathematics teaching systems in the United States and six higher-achieving countries to examine the teaching systems used in the U.S. and other countries. Videotapes and written descriptions of the lessons were included in the study. The sample consisted of a total of 638 eighth grade math lessons from Australia (87), Czech Republic (100), Hong Kong SAR (100), Japan (50), Netherlands (78), Switzerland (140), and the United States (83). The researchers looked into three different aspects of the lessons such as the way it was organized, the type of math presented, and mathematical processes used to solve the problems (Hiebert et al., 2005). It was noted that the coding was difficult because of the multiple lesson plans involved. Although inter-coder reliability was not assessed, the consensus of the judgments by all the researchers were used (Hiebert et al., 2005).

Hiebert et al. (2005) used an ANOVA and t-tests to assess teaching features such as presence and duration. A group of mathematicians and post-secondary math teachers analyzed a subsample of 20 lessons per country. The samples were randomized and Japan was not included in the subsample to exclude possible bias, because it had been examined by the same group from the TIMSS 1995 Video Study (Hiebert et al., 2005). Based on the analyses, the teaching in the U.S. was unchallenging and consisted of procedural math tasks. There were similarities in teaching compared to the other countries, but there was one teaching feature that was different that the other counties, the teaching system as a whole. There were notable differences between the U.S. and Japan (42% difference) and the U.S. and Australia (8% difference). In reference to the application type of problems per daily lesson, the U.S. had the lowest percentage with 34% occurrence, but the percentage was not far from the Czech Republic and Hong Kong with 35% and 40% respectively. On the other hand, Japan had 74% of their math problems per lesson required the use of application math problems. It was not determined whether it was real world application problems or otherwise (Hiebert et al., 2005).

Almost all the countries, except Japan, spent the majority of the time practicing familiar procedures in the classroom. The group of teachers and mathematicians rated the lessons based on level of content, with “5” indicating an advanced skill and lower ratings indicating elementary level skills (Hiebert et al., 2005). A rating of “3” was determined to be a math concept that was at grade level. Australia had the lowest rating with 2.5 and the U.S. with 2.7. The other countries were above 2.7, but less than 4.0 with Japan not included because they were not re-analyzed (Hiebert et al., 2005).

Math reasoning was another area examined. Math reasoning is a student's or teacher's ability to provide justification to solutions, generalize, provide counterexamples, and exhibit deductive reasoning (Hiebert et al., 2005). Twenty-five percent or less of the countries provided these types of problems in the lessons; however, the U.S. was the only country that did not have the justification types of math reasoning in their lessons. These types of problems the students had to justify or support their answers with evidence or examples (Hiebert et al., 2005).

The teaching methods have revealed that the United States should consider changes in their math policies, and instructional methods. The 8^{th} grade math lessons in the U.S. are not challenging compared to other countries (Hiebert et al., 2005). There was not a specific influence for the low math challenge, but multiple factors such as the types of problems focused on in class, math reasoning, and multiple representations of the math problem. The type of representation for the problems becomes important in teaching so that there can be a balance and more conceptual instruction (Hiebert et al., 2005).

Problem Solving Methods within Textbooks

Textbooks are a resource that teachers use for instruction. The representation of math problem solving in textbooks has an influence in teaching and learning (Fan & Zhu, 2007). The example problems and strategies that teachers use to teach their students are highly related. Fan and Zhu (2007) conducted a study to examine the way and problem solving was represented in math textbooks in China, Singapore, and the United States. Nine textbooks from the lower secondary level of the three countries were used. China had nine different series of books used while Singapore had two different series used in their countries. The U.S. had a wide variety of textbooks used due to being a larger country and the educational policies and materials that are determined by states rather than nationally.

The results revealed that defining problem solving was important. In addition, the problem solving models that were provided in the textbooks were important for students to use. Some textbooks, such as in Singapore's textbooks, had a general problem solving model outlined for all problems with different strategies and processes to use based on the presented concepts (Fan & Zhu, 2007). All textbooks had the general stages of problem solving: understanding the problem, devising a plan, carrying out the plan, and looking back. However, Singapore had the lowest percent (14.7%) of looking back as a problem solving strategy to execute. In addition, there was a low connection of Singapore's standards to its curriculum and textbooks using this strategy. It was also revealed that this final stage was not depicted with examples.

The looking back stage was divided into three parts: about the problems, about the procedures, and about the answers (Fan & Zhu, 2007). When students were asked to look back on a math problem, the problems, procedures, and answers were emphasized. China had 58.2% of its textbooks that contained looking back on the procedures, as opposed to the US and Singapore with 19.4% and 40.9% respectively. When solving math problems, it is not always about the solution, but understanding the students' mathematical thought process. If the students' thought process can be explained step-by-step, it can help teachers to understand students' reasoning in solving various math problems.

Overall, the U.S. had more additional teaching strategies for students' learning. The U.S. also had more students performing well on visual representation items than other the countries (Fan & Zhu, 2007). When students have knowledge of various strategies to use in their math problem solving, they can devise and attempt various methods to solve a problem (Montague & van Garderen, 2003). However, looking into student's demographic characteristics in relation to their math achievement can provide in depth information on specific differences.

Math Achievement Based on Demographic Characteristics

An important question has been posed within education, "What is the state of mathematics achievement for various demographic groups at the elementary and secondary levels in the United States?" (Tate, 1997, p. 653). The achievement gap has been prevalent among students of low SES and minority backgrounds (Ladson-Billings, 1997; Tate, 1997). In addition, gender gaps are rising in regards to math achievement (Collis, 1987; Else-Quest, Hyde, & Linn, 2010; Middleton & Spanias, 1999). The studies following will provide information in these areas.

Socio-economic Status (SES)

Many variables are said to affect students' math achievement. Shores, Smith, and Jarrell (2009) determined whether demographic characteristics such as gender, ethnicity, and socioeconomic status are contributors to students' math achievement. A sample of

761 fifth and sixth grade students from an Alabama school participated in the study. Of the participants, 42.6% were African American, 49.7% were White, 1.3% was Hispanic American, 2.1% were Native American, 1.7% was biracial/multiethnic, and 1.6% was of another racial/ethnic background unlisted (Shores, Smith, & Jarrell, 2009). In addition, 60% of the students received free/reduced lunch, 95% spoke English as the primary language at home, and 58.1% were female students (Shores, Smith, & Jarrell, 2009).

The students' academic performance was measured by collected data on the students' classroom performance in math, along with a teacher-created 20-item test aligned with the Alabama Course of Study and the Georgia Criterion Referenced Competency Test (Shores, Smith, & Jarrell, 2009). The researchers used a multiple regression analyses that revealed gender and SES were statistically significant negatively on students' math performance. Students with a low SES did not perform as high compared to their high SES counterparts. In addition, female students did not do as well in their math performance as the male students. However, ethnic differences were not significant. With these results, it is important to understand cases of differences among low and high SES groups of students at an earlier age. It is suggested that the lived context, home and school, by the child has a direct relationship with the students' math achievement.

Roska and Potter (2011) examined the home context's influence on students' academic achievement. Most of their research is focused on how parents' educational level, income, and occupational status affect how they support and influence their child's academic success. The researchers obtained their data from the Panel Study of Income Dynamics (PSID) and the Child Development Supplement (CDS). The PSID has been a longitudinal study that includes a sample that is a representation of the U.S. It has been used biennially since 1997 and used in conjunction with the CDS that includes information on children ages 0 to 12 and their parents. The sample in this study included children who were ages 6 to 14 in the 1997 PSID or 2002-2003 CDS follow-up (Roska & Potter, 2011). Academic achievement, parenting, social background were the variables that were measured based on gender, race, age of child, and mother's age at the time they had their child. Academic achievement was measured by students' math and reading scores from the Revised Woodcock-Johnson Test of Achievement. Parenting was coded as the parents' participation in their child's school while the Social Background was directed on the mothers' education because they tend to be the principal caregivers in a family.

The mothers' and grandmothers' education was aligned with the social class of a family (Roska & Potter, 2011). Although income or a persons' work is used to determine the socioeconomic status, the mothers' education was a relevant variable in the study for this area. The families in the study were in groups of new middle class, stable middle class, new working class, and stable working class based on the educational level and parental practices. The findings provided information on parents with higher educational levels tended to be more resourceful and influential in their child's academic success. In addition, the children with the highest academic achievement were in the stable middle class. On the other hand, children in the new working class did better than those in the stable working class but it does not last over time (Roska & Potter, 2011). Parenting practices are also related to children's' academic achievement due to the high levels of expectations, participation, and cultivation of experiences that parents use to engage their children. The results also showed that girls did better in reading, but not in math compared to boys. However, based on ethnicity, African American students did not do well on either content area. It was suggested to examine education as an avenue of mobility. Roska and Potter (2011) stated that research has shown education to be a tool of upward mobility, but not clear on how downward mobility affects children's academic performance. Furthermore, there have been suggestions regarding providing women with educational opportunities to improve their children's educational results (Roska & Potter, 2011).

Another outlook on students' educational achievement and their SES would be students' school context in relationship to their math achievement. Klibanoff, Hedges, & Marina (2006) who examined the relation between the amount of mathematical input in the speech of preschool or day-care teachers and the growth of children's conventional mathematical knowledge over the school year. The rationale of the study was based on existing research that focused on early mathematical input in preschool classroom settings. The emphasis has been on the effectiveness of enrichment or intervention programs. According to Klibanoff et al. (2006), other studies have also showed that comprehensive early intervention programs have a positive impact on children's math achievement as well as other cognitive and social skills.

The math skills of 198 children from 26 classrooms were assessed with 52 children eliminated from the study due to their absence when one of the assessments was given (Klibanoff et al., 2006). A 15-item mathematical assessment was used to assess the children's math knowledge along with the use of audiotapes. Children's math knowledge was evaluated individually at the beginning and end of the school year (Klibanoff et al., 2006). The researchers used an HML analysis and an ANOVA to analyze the data. There were marked individual differences in children's conventional mathematical knowledge by four years of age. Mathematical knowledge level was higher for children from high and middle SES backgrounds than children from low SES backgrounds (Klibanoff et al., 2006). Preschool teachers varied drastically in the amount of math talk they provided.

Math talk is when teachers or other adults and knowledgeable students can help generate communication and problem solving among the students. It consists of discussing math verbally, mathematically, and in written form in order to increase students' math knowledge and application. The amount of preschool teachers' math talk was significantly related to the growth of young children's conventional math knowledge over the course of the school year. An HLM analysis suggested that teacher input and children's math growth is distinctively related to teachers' math input. Preschool teachers may be able to foster the mathematical knowledge of children by using more 'math talk'

(Klibanoff et al., 2006). When students are exposed to an environment that embraces math positively, effectively, and often, students can develop their math skills.

There has been emphasis on group differences in students' experiences in a problem-centered mathematics classroom. Lubienski (2000) sought to understand the learning methods desired of low SES students. The study was conducted in a socioeconomically diverse school located in a medium-sized Midwestern city. The students came from a socioeconomic mix ranging from a few upper-middle classes all the way to lower class backgrounds. A majority of the 500 students in the school were Caucasian, with 2% Asian American, 3% Hispanic American, and 11% African American. The participants included 30 seventh grade students in the researcher's math class. There was an even number of male and female students, but not pertaining to racial/ethnic group. There were two African American males and one Mexican American female (family had lived in the United States for several generations). Twenty-two out of the 30 students consented to participate. Eighteen of the student participants provided additional demographic information to help categorize them into SES groups.

The participants used the Connected Mathematics Project (CMP). Students worked problems from this project in and out of school (Lubienski, 2000). The problems build on one another and lead into the next component. The program was to help students with math through engaging activities and provide various methods of solving the math problems presented within project. The goal was to lead students into abstract thinking by find relationships and patterns, be able to make conjectures in order to have a deeper understanding, and open opportunity in mathematics (Lubienski, 2000).

Lubienski worked as a teacher and a researcher in the study. The researcher observed the students in class and analyzed the audiotapes of their discussions. The students' class participation was coded in 20 categories that were designed to capture content, content, problem context, social context, reasoning, visual/tactile references, tone, correctness, insightfulness, mathematical relevance, and difficulty level associated with each contribution. Interviews and various surveys such as 60 questions were posed to the students whether or not their teacher gave them the answer to a math problem or encouraged them to figure out the math problems they struggled with on their own, and questions about the students' beliefs of math were gathered. Student work, teaching-journal entries, and daily audio recordings were also used to document students' experiences, including their struggles and successes with the math problems, their thought process throughout their learning, and what they found helpful or a hindrance (Lubienski, 2000).

Formal analysis with systematic examination of the teaching journal was conducted with transcriptions of all survey and interview data. The researcher also gathered information about the parents through surveys. She wanted to know about their occupations, educational levels, incomes, numbers of books and computers in the home, and newspapers read regularly. These were also used as SES indicators. This data was used to separate students in two categories: low SES and high SES (Lubienski, 2000).

Students were growing and achieving as a whole throughout the process of CMP. Many of the high SES students performed well on the CMP as opposed to the lower SES students (Lubienski, 2000). The students were not accustomed to the thinking process and problem solving required in the program, therefore believing the program to be “too difficult”. There were complaints of confusion, but it was noted that it could be due to the instructional methods and organization/wording of the material. However, some students believed that they had a better method to use in solving the problems and made the problems more relatable to their lives (Lubienski, 2000). Some aspects of the program were more liked such as the use of activities and games. Two themes emerged that were suggested for further research, students' perseverance and desire for direction when solving problems and issues of abstraction and contextualization.

Ethnicity/Race

The United States racial and ethnic demographics continue to change over time with increased diversity among students in the classrooms (Lee, 2002). However, there are apparent achievement gaps amongst different racial and ethnic groups such as White-Hispanic students and White-Black students (Lee, 2002). There have been several suggested methods of improving the achievement gap (Haycock, 2001), but the gap continues to widen (Lee, 2002). The national test scores based on the National Assessment of Educational Progress (NAEP) is a commonly used methods to measure the achievement gap (Lee, 2002). The NAEP has shown changes regarding the achievement gap over time. During the 1970s and 1980s, the achievement gap remained stable and close among the ethnic groups (Haycock, 2001; Lee, 2002). However, that is no longer the case today. Although many factors may attribute to the achievement gap, minority students are having more difficulty in math achievement compared to their White counterparts (Ladson-Billings, 1997; Martin, 2006).

Overall, Black students in the U.S. have the lowest math achievement (Entwisle & Alexander, 1990). The reason is not fully understood, but changes to instruction and curriculum are possible solutions (Entwisle & Alexander, 1990). A study on Black and White students was conducted by Entwisle and Alexander (1990) to examine their math competence in 1st grade. A large random sample of 825 students from the Baltimore City Beginning School Study (BSS) was obtained. The samples drawn by the researcher contained information on the students' race and socioeconomic status with equal numbers of each racial/ethnic group. Test scores were obtained from children in December 1982 (first half of their 1st grade school year) using the California Achievement Test to assess their math and verbal skills. Students who repeated kindergarten was not included (Entwisle & Alexander, 1990). Data of the students' parents were included based on interviews: prekindergarten experience, kindergarten experience, estimate of students' ability, parental expectations, meal subsidy, educational level, and family type (Entwisle & Alexander, 1990).

Entwisle and Alexander (1990) found that parents' educational level had a direct influence on students' math reasoning. The higher level of educational a parent held, the better their child performed in math, which was seen with White students who outperformed Black students in this area by 23 points. The other parental factors such as family type and expectations, and estimate of students' ability were influential. However, it was noted that the expectations could have a psychological effect on the child (Entwisle & Alexander, 1990). In addition, Black boys outperformed Black girls, a trend that was reversed in White students.

The sample was selected because it was easier to assess their growth processes when students are in the early stages of schooling, because their cognitive development is at the beginning stages (Entwisle & Alexander, 1990). Before first grade, all students were similar in their mathematical reasoning and verbal skills, but it changed during their first grade year based on race, SES, and other variables that were previously mentioned. The researchers found there were differences based on race, but they were not statistically significant. On the other hand, social class was a predictor of students' math achievement (Entwisle & Alexander, 1990). Gender differences were apparent and the researchers mentioned that it was prevalent in middle childhood based on perceptions of the parent and the students.

The math achievement gap of Black and White students was examined at the secondary level. Lubienski (2002) selected a sample of 4^{th}, 8^{th}, and 12^{th} grade students from the NAEP data. Socioeconomic backgrounds of the students were also considered based on the parents' educational level and literacy resources. The instructional-related variable was included based on racial differences only (Lubienski, 2002). The results revealed that many students had at least two or more literacy resources. In regards to math achievement, the NAEP mathematics achievement is based on a 500-point scale. The students performed on average, 228 in 4th grade, 275 in 8th grade, and 301 in 12th grade in 2000 (Lubienski, 2002). The Black-White achievement gap was 31, 39, and 34 points respectively. This was noted to be similar to the 1996 Black-White math achievement gaps. Lubienski (2002) stated that the math achievement gaps are severe because the 8th grade White students scored 8 points higher than the 12th grade Black students. In addition, the gaps were consistent in 1990-1996 with the 4th and 8th grade students and decreased in 12th grade. However, the gaps were large within the high SES, within the low SES, and between both groups. Even the low SES White students performed, on average, equal to or higher than the high SES Black students (Lubienski, 2002).

There were many apparent differences between Black and White students based on students' math instruction and other variables such as technology use, beliefs about math, attitudes, and experiences (Lubienski, 2002). More White students took higher level math in 12th grade, but it was reversed for the low SES groups. The researchers saw this as discouraging because the math achievement gaps were narrower with Whites at 84% and Blacks at 74%. Many students believed math to have only one method to solve a problem and that math was about memorizing facts. These beliefs were similar for both groups and strongest among 4th grade students (Lubienski, 2002). Similarities and differences were apparent with instructional practices in math. During 1990-1996, calculator use increased. Students were able to use calculators for everyday learning and computations. In1996, students had computer access as part of instruction, but in 2000, it was mainly used for memorization or drill and game practice of math facts for Black students (Lubienski, 2002).

Problem solving and critical thinking skills are to be embedded in mathematics education based on the national standards. The White-Black gap was not wide in students' access to math resources, yet there was a wide gap in their overall math achievement (Lubienski, 2002). The students' SES was a limitation within the study because they were based on self-reports. Lubienski (2002) suggested using other methods to gather information on their SES background such as using a questionnaire to gather information on what the family spends on. Holloway (2004) mentioned six principles from NCTM that will help to overcome the racial disproportion in math achievement, including clear, high expectations; logical curriculum; understanding of student needs; instruction that builds on students' prior knowledge; alignment of assessment and instruction; and technology that enhances students' learning. Without adhering to these principles, the risk of losing the opportunity to close the minority achievement gap in math easier.

Gender

Male students commonly outperform their female counterparts in math (Entwisle & Alexander, 1990). Often, male students are held to higher expectations in math than the female students (Entwisle & Alexander, 1990). Expectations based on gender can also alter a student's perceptions and behavior in school and life. Collis (1987) examined attitudes towards math and computers based on sex differences. It was hypothesized that females would hold more negative views towards math than males. The participants were in 8th grade and 12th grade in the British Columbia school district. There were 1,818 student participants that represented one of the two grade levels. The 8th graders had 20 hours of computer work they had to accomplish throughout the year as their math course requirement. A survey was used to gather information about their attitudes towards computers and math. The results showed students' attitudes toward math were also a predictor of their attitudes towards computers. It also showed female students were more apt to express negative feelings towards math.

Another similar study examined gender differences in students' achievement in math and attitudes toward math (Else-Quest et al., 2010). Statistical data were provided pertaining to gender differences in math. The researchers meta-analyzed two major international data sets, the 2003 Trends in International Mathematics and Science Study and the Programme for International Student Assessment. This resulted in a sample of 493,495 students 14–16 years of age. Results showed that there was a small variance on gender affecting student achievement in math. However, gender differences in math achievement correlated with gender differences with self-confidence in math. The researchers concluded that there may be some gender differences in achievement. Female students did not achieve as high in math as the male students. In addition, the boys had higher levels of positive attitudes toward math than the girls (Else-Quest et al., 2010).

Other factors such as instruction and curriculum were suggested as having a direct effect on students' learning.

Another possible effect on students' learning pertains to their motivation. Middleton and Spanias (1999) investigated the motivation behind math achievement. Motivational factors were found, such as a trend for girls who tend to yearn for a connection with their math teacher as opposed to boys. Some of the motivation students have to do well in math stems from their initial like or dislike of math instruction during the transition from elementary to middle school. The researchers had similar findings with Else-Quest et al. (2010) in reference to the method of instruction and teacher attitudes were factors also intertwined with student motivation to be successful in math.

There are also other factors that impact students' math achievement. Hall (2009) conducted a quasi-experimental study which involved 170 sixth and seventh grade students in Middle Tennessee to determine if students' genders, grade levels, and level of creativity had an impact on their use of mathematical problem solving strategies. After six weeks of intervention and data collection, the result revealed that those students who received previous problem solving instruction had both higher numbers of solutions and higher levels of complexity in the sixth and seventh grades. There was a difference in the number of methods by gender at the sixth grade level with female students solving more problems than the male students (Hall, 2009). However, the results revealed that there was no significant difference in the number or complexity of solution methods by either grade level (Hall, 2009). This means that although research has shown female students performing at lower levels than males in math, providing problem solving strategies can help both female and male students achieve higher levels. However, some students need support, so there is more depth and complexity in their problem solving skills. Therefore, it is important to examine other factors that may influence the gender gap in math.

Math Anxiety

Math anxiety has been a problem for several years, but the reason for this has not been certain (Ashcraft, 2002). Many factors have been suggested as contributors to students' math anxiety, such as teacher instructional methods, students' perceptions and attitudes towards math, students' past experiences with math, and the difficulty level of the math problems students are presented with (Ashcraft, 2002). Math anxiety as defined by Khatoon and Mahmood (2010), "is a feeling of tension and anxiety that interferes with the 'manipulation of mathematical' problems in varied situations" (p. 75). It was first assessed by Richardson and Suinn's 1972 Math Anxiety Rating Scale (Ashcraft, 2002). According to Ashcraft (2002), this scale posed various questions to students about their math anxiety. Ashcraft (2002) also used a shortened version of the scale with a rating of 1 to 10 of not being anxious to very anxious on questions such as, "how anxious are you about math?" and yielded the same correlations of 0.49 to 0.85.

Personal and educational consequences of math anxiety have surfaced over time (Ashcraft, 2002). Students may take fewer math courses in high school and college, as well as avoid careers that involve math (Ashcraft, 2002). Math anxiety also has been linked to students' retention of information and lack of confidence (Ashcraft, 2002). Yet, there are debates on the direct relation of how parental anxiety, teacher anxiety, societal, educational, and other environmental factors influence students to have mathematics anxiety (Newstead, 1998).

Math anxiety often begins within the elementary school years (Ma, 1999), although research has primarily been conducted with high school students (Newstead, 1998). Children during the elementary and middle school age group deal with many rapid changes which cause anxiety and one of the major changes is the transition from elementary to middle school (Newstead, 1998). Math anxiety may interfere greatly with a student's success with math in the classroom and the real world (Newstead, 1998). Math anxiety may create a negative relationship with math, negatively impacting a child's academic achievement (Newstead, 1998). There are multiple elements of math anxiety. For example, children with math anxiety either dislike math, worry about math, and/or fear math which are attitudinal, cognitive, and emotional elements, respectively (Ma, 1999).

Ho et al. (2000) studied math anxiety's relation to students' math performance. A sample of 671 6th-grade students from China, Taiwan, and the United States was selected for the study. There were 211 students were from China (92 girls and 119 boys), 214 from Taiwan (106 girls and 108 boys), and 246 from the United States (111 girls and 135 boys). The researcher inquired about whether a two-factor (affective and cognitive) model of math anxiety was a better fit to test the samples from the three nations than a one factor model, if the affective and cognitive factors of math anxiety contrasted when linked with the success of math, and if any relations differed amongst the three national samples. Differences in gender were also examined.

The participants received the mathematics achievement test to assess their basic math knowledge and the math-anxiety with the Math Anxiety Questionnaire (MAQ). The students were chosen from both urban and rural school settings and in an effort to acquire an adequate representation of each nation. Schools were also chosen by their educational, economic, institutional and residential qualities and references of the particular scholastic authorities and scholars in each nation (Ho et al., 2000).

The researchers used a confirmatory factor analysis along with testing the fit of data by using the chi-square statistic, goodness-of-fit index (GFI), comparative-fit index (CFI), and root-mean-square-error-of-approximation (RMSEA) (Ho et al., 2000). The confirmatory factor analyses reinforced the hypothesis. There were differences among affective and cognitive dimensions of math anxiety (Ho et al., 2000). The analyses of a structural equation model indicated that the 2 factor model was a better predictor of the multiple dimensions of math anxiety (Ho et al., 2000). In regard to students' cognitive domains, there were no statistical differences between China and the U.S., but the Taiwanese students had a positive correlation suggesting that their cognitive worry factor may serve as a motivator for the students (Ho et al., 2000). There was a negative correlation between all the students' affective domain and their math performance. Math anxiety affected the student emotionally. Also, female students showed an overall higher level of math anxiety than males (Ho et al., 2000).

Another study on math anxiety was conducted by Ma (1999). The study was a meta-analysis of 26 studies with 18,279 students in Grade 4-12. Each of the samples within the studies averaged 703 students. The largest study had a sample size of 4,091 students and the smallest study had a sample size of 28 students (Ma, 1999). The researcher sought to understand the relationship between anxiety towards math and math achievement, and the differences within different groups such as gender, grade level, ethnicity, instruments used, as well as the time and type of publications used. The Mathematics Anxiety Rating Scale (MARS) was the scale used because of its validity and reliability. The students were grouped by grade levels: Grades 4 to 6, Grades 7 to 9 and Grades 10 to 12 with only two ethnic groups, Black and White. The results showed that there was a significant difference between math anxiety and math achievement. Students with higher levels of anxiety in math had lower math achievement.

Ma (1999) concluded that math anxiety occurred during early educational experiences. But there is not an instrument to study math anxiety at the grade levels prior to Grade 4 (Ma, 1999). The researcher further concluded that children during early adolescence deal with an increase of uneasiness, worry, and anxiety associated with learning math. The researcher measured the relationship of the students' cognitive and affective domains. The major elements of the affective domain were emotion, belief, and attitudes. The emotional element is the trigger for math anxiety because it involves fear, panic, anxiety, and embarrassment which the students' showed in situations involving math (Ma, 1999).

Sometimes math anxiety is assumed to be related to test anxiety, but Batton (2010) indicated that math anxiety was not the equivalent of test anxiety since the math anxiety of students originated from different areas. To further discover what issues and considerations would create math anxiety, future researchers could utilize different math anxiety scales to reveal what contents and areas students would result in their math anxiety increasing. Krinzinger, Kaufmann, and Willmes (2009) conducted multiple studies concerning math anxiety among elementary and middle school students. Although similar to the aforementioned research on math anxiety, the purpose of these studies was to recognize likely components of math anxiety, determine the possible relationships between math anxiety and personal outlook on math, such as opinions, ideals and performance, and determine if age or gender was associated with math anxiety. It was hypothesized that the older participants would have more math anxiety than the younger participants and girls would have more math anxiety than the boys, particularly at higher grade levels.

The study occurred in a two year time span that consisted of different samples. The sample of the first year consisted of a random sample of 740 white (majority), middle-class students in grades 5-12. The sample in the second year consisted of 575 children in grades 6-12 (88% of the Year 1 students in Grades 5-11) and of these children, there were 298 boys and 266 girls (Krinzinger, Kaufmann, & Willmes, 2009). The students took the Math Anxiety Questionnaire (MAQ) and also took the Student Attitude Questionnaire (SAQ) which was given in the spring of each year. The SAQ aids in providing insight on children's views and outlooks about mathematics and measures the students' prospects for achievement, incentive values, perceived ability, perceived effort, and perceived task difficulty in both math and English (Krinzinger, Kaufmann, & Willmes, 2009). In addition, other constructs such as sex role identity, sex stereotyping of math as a male domain, causal attributions, and children's perceptions of their parents' and teachers' attitudes regarding their abilities in math were examined (Krinzinger, Kaufmann, & Willmes, 2009). The MAQ was given only during Year 2; therefore the primary focus of the study was placed on the second year.

A point scale system was created for the correlation analysis and a confirmatory analysis factor was used to compare the math anxiety shown in different genders and age groups. In addition, numerous goodness-of-fit tables were observed along with chi-square data. The results showed that the emotional factor of math anxiety highly and negatively correlated with their self-skillfulness and ability to perform in math than the concern aspect, a cognitive level of anxiety (Krinzinger, Kaufmann, & Willmes, 2009). However, the concern aspect of math anxiety was highly and more positively correlated to the significance children placed on math and their conveyed real effort in math than the emotional factor of the students' math anxiety. Girls showed more negative emotional responses to math than the boys and the ninth-grade students showed the most feeling of concern about math, while the sixth graders showed the least (Krinzinger, Kaufmann, & Willmes, 2009). Math anxiety is related to the emotional domain of a student (Ho et al., 2000; Ma, 1999). Although students' math anxiety can affect their math achievement, students can have the opportunity to reduce their anxiety and achieve well in math (Ashcraft, 2002). Therefore, looking into students' beliefs, attitudes, and perceptions about math can provide insight into helping improve their math achievement and performance.

Math Attitudes and Perceptions

Mathematics is one of the most difficult content areas for students to comprehend. Although there is an underlying respect and value for math, it is deemed as highly difficult by some adults and children (Ellis & Berry, 2005). Society has accepted the pessimistic views and has become complacent in the mindset of not knowing math well because it is complicated (Ladson- Billings, 1997). These negative perceptions of math along with other images attached to the dislike of math are causing "children to be unprompted to embrace mathematics as an area of study or necessary skill" (Ladson-Billings, 1997, p. 699).

Although the negative perceptions are prevalent among students and adults, there are teachers and organizational groups that work to change this continued perception. Student Teams Achievement Divisions (STAD) is a cooperative learning technique believed to help students on their perceptions of math. Odom (2010) measured the effectiveness of the STAD instruction method on 92 7th and 8th graders' perceptions of math in a rural middle school in Tennessee. The student perceptions toward math were measured using the Sandman's (1973) Mathematics Attitude Inventory. The treatment group was a group that was taught by the researcher who was trained with the STAD method. The control group was taught by a teacher who had tenure, but not trained in the STAD method. Both teachers had a collaborative relationship because they planned and taught the same lessons on a regular basis.

The study was conducted for nine weeks with data being collected at the beginning and ending of the study. Independent two-tailed t-tests with a 0.05 significance level were used in the analyses. The results showed an increase of 4 points from the pretest to posttest within the control group, but the treatment group decreased by 52 points (Odom, 2010). The researcher stated the findings were unexpected because cooperative learning is supposed to yield a greater perception because students are working with others and discussing the content with increased understanding. The interpretation of the findings discussed the importance and success of cooperative learning groups (Odom, 2010). However, there were suggestions that the STAD technique may not be the most appropriate technique. Cooperative learning should happen where students' creativity and choice of problem solving skills can be used (Odom, 2010). Although STAD may not have been a successful indication of students' perceptions, it was suggested that using an enhancement program could improve middle school students' perceptions of math. It was further suggested that student perceptions of math is an area that still needs to be researched.

Although students may have negative perceptions of math due to their experiences, some students lack intrinsic motivation in math, a factor of students' attitudes and perceptions towards math (Middleton & Spanias, 1999). According to

Bandura, the manner in which students perceive themselves affects how they will succeed on various tasks (Bandura, 1986). For example, Henderson and Landesman (1992) studied achievement, attitudes, and motivation in mathematics of students of Mexican descent. The researchers used a thematic math instruction, a collaborative and integrative instructional method for the experimental group. The random sample consisted of 102 7th grade students who were 90% Hispanic and 60% with limited English proficiency (Henderson & Landesman, 1992). The themes were taught in English, but the students were allowed to be tested in English or Spanish for the pretest and posttest. The assessments aligned with the school districts' standardized tests. There was a math computation and application section with an alpha reliability of 0.84 to 0.86 for computation and 0.77 to 0.88 for the application sections (Henderson & Landesman, 1992). Information on students attitudes were also gathered that paralleled the NAEP study by Lee and Fish (2010) where examined the total achievement gains from 4th to 8th grade based on age, the combination of entrance age and the age at the time of the test, and grade level. The results showed that students improved on their math achievement from 4th grade to 8th grade, but higher gains were made in the other countries compared to the United States. A 4-point Likert scale was used that ranged from "strongly agree" to "strongly disagree".

The study lasted two years with each year focusing on a set of themes. During the first year environmental and fine arts themes were the focus and careers, world issues, sports, and the future were focused on during the second year (Henderson & Landesman, 1992). Students represented the themes mathematically. The results yielded no differences in attitudes or perceptions of math for both groups. However, the motivational variables within the attitudes and perceptions scale were a predictor of their achievement (Henderson & Landesman, 1992). Both groups made gains in their math achievement, but it was obvious that the gains were greater with the experimental group. There was optimism in a thematic math instructional curriculum, but there was also the awareness that all students may not have the opportunity to experience this type of learning process (Henderson & Landesman, 1992). However, it was suggested that math should be taught through engaging, interactive methods and guidance, but also in a way relatable to real life.

Ogbuehi and Fraser (2007) investigated the use of engaging, interactive teaching methods about linear equations on students' attitudes towards math. The sample consisted of 8th grade students from California. The students were from a low SES background and 46% were African American, 51% were Hispanic and 3% were of another racial/ethnic background. There were 661 students from 22 classrooms that partook in the study. Surveys regarding the participants' learning environment and attitudes were collected. A subsample of 101 students answered questions on achievement and concept development in addition to the other surveys. The math achievement test was created to assess students' learning of linear equations in the classroom. The measures included in the study were the *What Is Happening In this Class?* (WIHIC) questionnaire that inquired about involvement, investigation and task orientation of learning in the classroom, the

Test of Mathematics Related Attitudes (TOMRA) on students' math attitudes based on teaching methods used in the classroom, and the three scales from the Constructivist Classroom Learning Environment Survey (CLES) that evaluated the classroom environment's consistency with the constructivist teaching approach and awareness of ways teachers can restructure their classroom teaching routines (Ogbuehi & Fraser, 2007).

The researchers performed a one-way ANOVA to test for possible differentiation between the perceptions of the classes. The results revealed that there were statistically significant differences. This means that the scales were able to differentiate between the perceptions of students in different classes (Ogbuehi & Fraser, 2007). Pretest and posttest changes for the experimental and control groups were examined on classroom environment, student attitudes towards math, and student achievement in math. Ogbuehi and Fraser (2007) found greater changes from pretest to posttest within the experimental group based on classroom environment perceptions, attitudes to mathematics and mathematics achievement. An ANCOVA was used to test differences between the two groups on the posttest scores, the results were significantly different. There was an overall positivity that was related to students' math achievement and attitudes towards math (Ogbuehi & Fraser, 2007). As the students became comfortable and engaged in their learning, they felt better about their experiences. Implications for future research discussed by the authors included the use of more rigor and increased challenging math tasks to help promote students' problem solving skills, including having a classroom that emphasizes aspects of constructivism. Students appreciate innovative ways of learning math in the classroom because it provides an avenue for students to comprehend what they are learning through interactive and engaging tasks with comfort (Ogbuehi & Fraser, 2007). This provides students a positive experience in the math classroom that could help in decreasing the negative attitudes and perceptions students have about math.

Technology and Math

Importance of Technology

Throughout time, the invention of the television, calculator, computer, internet, and other technological tools have been an influential wave of change in the world (Moss, 2004). All these tools have been invented to bring about change in the way people live (Moss, 2004). The inventions of various technological tools and their continued improvements have played a vital role in our society. People are now able to do things such as build and expand businesses and communicate in a quick and simple manner with the use of technology.

In 2005, 6th graders across the United States were surveyed regarding their technological experiences (Project Tomorrow, 2011). Half of 6th graders owned a cell phone, one- third owned a MP3 player, and many 6th grade students complained that the internet at their school was too slow and blocked too much content that was needed for school work. Today, the numbers of 6th graders who have these technological devices have increased drastically in some cases, especially with the use of social networking sites (Project Tomorrow, 2011). These 6th graders and other students are becoming more “technologically savvy” (Project Tomorrow, 2011, p. 2) and require their teachers and schools to provide the means to enhance their “digital learning opportunities” (Project Tomorrow, 2011, p. 2). Furthermore, educators today have more access to use various types of technological tools to educate students (Moss, 2004).

Calculators have been the main technological tool used in the math classroom; however, computers and the internet play a vital role in the educational system (Moss, 2004). They have provided easy access to information for research or personal interest, storage, and the presentation of information to aid in effective teaching (Moss, 2004). In addition, computers are becoming more accessible to students at home and in the classroom and their use has been integrated within learning (Moss, 2004; Zucker, 2006). Although computer is a valuable tool, it is not used to replace the traditional teaching methods, but rather used to enhance student learning (Moss, 2004).

Computer technology provides support in students’ learning in multiple ways (Moss, 2004; Project Tomorrow, 2011; Roschelle, Pea, Hoadley, Gordin, & Means, 2000). Roschelle, et al. (2000) discussed the influence computer technology has on supporting student learning through active engagement, participation groups, frequent interaction/feedback, and real world connections. Students learn better when they are able to construct knowledge rather than simple rote memorization (Roschelle, et al., 2000). When students are presented with engaging tasks, they can communicate, analyze, and problem solve through those tasks that will help them in their school content and beyond the classroom (Suh, 2010).

Technology use can also be collaborative when students are engaged in tasks and working together with frequent interaction and feedback from their peers and the computer program (Rittle-Johnson & Koedinger, 2005). Computer technology programs become helpful learning tools when students are able to connect their learning to the outside world. An example of real world application is a student solving math problems on a computer program that relates to everyday life such as adding decimals. Decimals are used every day in relation to money and students can extend their knowledge of decimals to how decimals are used in various careers on a daily basis.

Use of Technology in the Math Classroom

Math is a challenging content area for many students and even adults (Lubienski, 2000). However, math skills are used to solve problems and make decisions. Examples can be seen in data trends, spatial relations, and applicable to financial budgeting and planning (Roschelle et al., 2000). Therefore, differentiated instruction is a teaching philosophy that is used to provide students multiple avenues to learn their academic content (Nazzal, 2011). Different methods include, but are not limited to individual work, collaborative groups, think-pair-share (work in partners), whole class, concrete learning with manipulatives, writing, and using computer assisted instruction (Mendicino, Razzaq, & Heffernan, 2009; Rittle-Johnson & Koedinger, 2005; Zhang, 2005).

Studies have compared the strategies used in traditional and computer assisted classrooms such as Zhang (2005) who examined computer technology as a solitary instructional method compared to traditional teachings and Mendicino, Razzaq, and

Heffernan (2009) who examined computer technology, specifically web based systems, in relation to students' homework. Zhang (2005) conducted two quasi-experiments with a total sample of 108 6^{th} graders (53 in experiment 1 and 55 in experiment 2). The students were separated into two groups for both studies: the experimental group that received the computer assisted instruction, Interactive Middle School Math Bundle and the control group that received the traditional instruction. Zhang (2005) defined the computer assisted instruction as a web-based program that included tutorials, drill and practice, games, and simulations while the traditional instruction consisted of direct teacher instruction with math books, worksheets, and drill practice of concepts. Independent t-tests were used to analyze differences between the two groups in both studies on their pretest, but there were no statistical differences.

Zhang (2005) used independent t-tests to look at differences between the experimental and control group from their pretest to posttest in both experiments, but there were no statistically significant differences. Students did improve from pretest to posttest whether they received the traditional or computer assisted instruction. This slightly differed from Rivet's (2001) study that examined the same comparison of teaching methods with 6^{th} grade students. The results showed an overall higher math achievement with students who received the computer assisted instruction. Although Zhang's (2005) study did not provide differences in teaching methods, it was suggested that one method is not better than the other. Rather, computer programs can be used as an enhancement rather than in isolation.

Technology tools, such as online visual, interactive technological tools, can be used to provide scaffolding that children can use to understand concepts in math (Rittle-Johnson & Koedinger, 2005). Although they are not social interactions with people, it is an interaction between a student and computer program because they are engaged in the visual and interactive activities that will assist them in their learning. Therefore, providing students with a learning environment that fosters this interaction could possibly improve students' math problem solving and basic skills.

Rittle-Johnson and Koedinger (2005) conducted a study that focused on improving students' conceptual, contextual, and procedural knowledge. Three phases of the study were executed with 223 6th grade students. The sample came from 6th grade students of two different populations. One school had 137 of the students from an urban, public middle school with 78% of students who were considered economically disadvantaged with 50% White and 49% African American students (Rittle-Johnson & Koedinger, 2005). The sample group used from the second school consisted of 86 students that were from one suburban elementary and one suburban middle school. A combined 22% of both schools were economically disadvantaged and over 95% of the students were White (Rittle-Johnson & Koedinger, 2005). The urban, public school used the Connected Mathematics curriculum, four days a week, that was aligned with the National Council of Teachers of Mathematics standards while the suburban, public schools combined a problem-based paper curriculum and an intelligent tutoring system each week in a computer lab (Rittle-Johnson & Koedinger, 2005).

The three phases consisted of identifying the students' prior knowledge in math (basic and story based problems on fractions) that was assessed using a difficulty factor assessment (DFA) as the pretest (Rittle-Johnson & Koedinger, 2005). Phase 2 consisted of a created intervention based on students' prior knowledge, the implementation and use of a computer based program for all students. During the intervention, students used a computer program to solve the problems based on their prior knowledge. When students did not answer or solve the problem correctly, feedback was provided from the program as a guide. Phase 3 included the assessment after the intervention (Rittle-Johnson & Koedinger, 2005).

The results provided information on students' problem solving skills in relation to students' conceptual, contextual, and procedural knowledge. Based on the pretest, the students had some prior knowledge on fraction operations. However, the students from the suburban schools had a higher average accuracy than the students form the urban school with 62% and 35%, respectively (Rittle-Johnson & Koedinger, 2005). There were four scaffolding techniques used based on their prior knowledge: conceptual, contextual, procedural, or none needed. Although the scaffolding reduced the difficulty of the problem, students were more successful on procedural scaffolding such as finding the common denominator of two fractions than the other techniques (Rittle-Johnson & Koedinger, 2005). Students had the opportunity to write down and solve the math problems from the intervention on paper, but some students did not show much evidence of alternative strategies used to solve the problem.

All the students were given a posttest in Phase 3 of the study, but 33 of the students did not take the test due to their absence. Overall, students solved the problems correctly on the posttest (Rittle-Johnson & Koedinger, 2005). The gain from pretest to posttest averaged 37%. The researchers stated that school was not a factor overall, but there were some differences. The students from the suburban schools performed higher than their counterparts, but it was assumed to be due to the completion of more problems during the intervention time and their engagement in the presented problems (Rittle-Johnson & Koedinger, 2005). In this study, the use of the program was helpful to the students because of the scaffolding and visual representation of the problems that guided students in their math problem solving (Rittle-Johnson & Koedinger, 2005). It was suggested by Mendicino, Razzaq, and Heffernan (2009) that web-based programs for math homework were better than the traditional paper-pencil homework when feedback is provided. This presents evidence that computer programs can be effective learning tools to use in math learning.

Similarly, Koedinger, McLaughlin, and Heffernan (2010) conducted a study using an online technology tool. However it was an assessment and tutorial system to aid in avoiding loss of instruction time. Seventh grade students from a Massachusetts urban middle school were participants in the study. There were four schools that were included with a total of 1,344 students that included regular and special education students

(Koedinger, McLaughlin, & Heffernan, 2010). Below is the breakdown of the schools:

> Treatment school A 372 students (78% regular), Treatment school B included 322 students (81% regular), Treatment school C included 253 students (77% regular), and Comparison school D included 293 students with 81% as regular education students (Koedinger, McLaughlin, & Heffernan, 2010, p.497).

Schools A, B and C were the treatment schools that received the ASSISTment online intervention program while school D was a comparison group because they did not have computers at the time of the study. When the treatment groups worked in the computer lab, School D would work on traditional class activities. Pretests were given at the end of the students' 6^{th} grade year and posttests at the end of their 7^{th} grade year (Koedinger, McLaughlin, & Heffernan, 2010).

The standardized assessment used was the Massachusetts Comprehensive Assessment System (MCAS) as the pretest and posttest for their grade level. It is a conventional benchmark assessment for the state (Koedinger, McLaughlin, & Heffernan, 2010). ASSISTment is an online assessment and tutoring program for students' learning. The program tutors by scaffolding and providing hints when students get an answer incorrect. Students were given a question on classifying angles, such as being asked what a 90 degree angle looked like and when students needed guidance, they were shown other figures that contained the 90 degree angle. Scaffolds provide assistance by asking additional questions or providing a visual representation to guide the student in answering the original answer. Hints, on the other hand, may provide a definition which may not be as helpful if the student does not know the concept (Koedinger, McLaughlin, & Heffernan, 2010). This was also exemplified in Mendicino, Razzaq, and Heffernan's (2009) study that scaffolding is proficient in online technology use.

A 2 X 2 (condition was treatment vs. control and the student group was regular vs. special education) ANCOVA and pre-test was the covariate used to test for differences between the treatment and control group (Koedinger, McLaughlin, & Heffernan, 2010). Increases were not expected from pretest to posttest because the MCAS is difficult in 7th grade compared to 6th grade (Koedinger, McLaughlin, & Heffernan, 2010). Overall, the students in the treatment group performed better than those who did not receive the online intervention program. Subgroup population variables were also considered: gender, race, free lunch availability and limited English proficiency (LEP). It was also noted that the students in the treatment group of those subgroups outperformed their counterparts in the control group (Koedinger, McLaughlin, & Heffernan, 2010).

The amount of use of the program by students and teachers was examined based on the number of questions completed (less than 60 were considered low usage and more than 60 were high). In reference to regular education, students' teachers who adjusted their teaching based on the ASSISTment program's advice had students of the low-usage and no-usage group benefit in the classroom, but there was no effect on the high-usage students (Koedinger, McLaughlin, & Heffernan, 2010). Special education students on average completed 91.6 items for high users and 19.9 items completed for low users. Of the special education students, 30% were with teachers who did not use the program's suggestions, 34% with low usage, and 34% with high usage (Koedinger, McLaughlin, and Heffernan, 2010). Koedinger, McLaughlin, and Heffernan (2010) noted that treatment schools had an inclusion model with 70% of the special education students in regular education classrooms as opposed to the control group with only 43%.

Students showed an overall improvement with the use of the program for a full school year (Koedinger, McLaughlin, & Heffernan, 2010). Students were able to retain the information because of the consistent testing, but also with the scaffolding and hints that were provided within the program (Koedinger, McLaughlin, & Heffernan, 2010). In addition, the more problems completed by the students, the higher their score. This is not a definitive reason for higher achievement, because the time given could have an effect on the gains in learning math (Koedinger, McLaughlin, & Heffernan, 2010). The 7th grade students performed considerably higher on the MCAS than the control group. Unfortunately, random assignments were not provided so it was not certain if the program was the sole influence (Koedinger, McLaughlin, & Heffernan, 2010).

In a similar study, highlighting assessment, Bottge, Rueda, Kwon, Grant, and LaRoque (2009) compared computer and paper-pencil based assessment with high, medium, low achieving 7th graders in math. Students were from a rural middle school in the Midwest with random assignments of the participants used to determine the two groups to measure their math learning from the enhanced anchored math instruction (Bottge et al., 2009). Students received instruction that aligned with the NCTM Math standards for grades 6-8. Students received a maximum time of 80 minutes and were measured on the concepts in Fraction of the Cost (video based problem) and the Hovercraft Challenge (hands-on problem). Both were problems that required problem solving skills. The results showed that higher achieving students scored highest overall and lower achieving students scored lowest overall. Students improved overall from pretest to posttest with both methods of instruction (Bottge et al., 2009). However, low-achieving students benefited from the computer based test because they were able to navigate through it. The low-achieving and advanced students used the same amount of time to solve the problems. In addition, the scaffolding was effective and widely used by the low achieving students to help their learning (Bottge et al., 2009).

The paper-pencil test provided pictorial representations and less text for students with reading difficulties, but it lacked the interactive component that was in the computer based test (Bottge et al., 2009). It was also restrictive in providing students' problem solving strategies. Limitations were expressed such as lack of diversity and high number of high achieving students (Bottge et al., 2009). Despite the limitations, the researchers were able to conclude that computer based assessments could be beneficial to student learning because it provided a visual and interactive component (Bottge et al., 2009). Moreover, it provided students a contextual format that extended the basic math skills and included real-world application problems.

Technology, specifically computer based technology programs, provides students multiple representations of what they are learning in math to better understand abstract concepts (NCTM, 2012). Due to the world becoming technologically advanced, the methods used must be advanced as well. Teachers can use online visual and interactive tools to help students construct and facilitate their knowledge (Orabuchi, 1992). When computer assisted programs are incorporated in the classroom, students are engaged and perform on higher levels (Bottge et al., 2009). It provides students consistent visual and interactive learning opportunities in addition to the strategies learned and used in the classroom.

Summary

The literature review provided theory and research of the importance of math, math achievement/performance of the United States compared to other countries, demographic differences within the United States, with evidence of students' math anxiety, math attitudes/perceptions, and use of technology with math. Math is important at the early stages of learning and development to build a strong foundation that eventually leads to students to appreciate math and its application in the real world. However, students in the U.S. are not achieving at high levels compared to their counterparts in other countries and also with notable differences within the U.S. based on demographic characteristics.

Students' math anxiety and attitudes/perceptions affect students' math achievement, when students have a fear of math, the student feels incapable of mastering math. In addition, their attitudes become increasingly negative and can cause them to not have a strong self-efficacy in their abilities. Furthermore, their math performance becomes consistently low. Part of math performance is being able to problem solve and apply those skills in the classroom and daily world. Some students give up when there is difficulty in understanding the various math problems presented, so looking for avenues to decrease anxiety and increase positive attitudes/perceptions becomes critical. Therefore, engaging and motivational tools are possible strategies can help students in math. Technological tools are examples of interactive methods used to enhance instruction because computer programs offer visual, virtual manipulatives, and grasp students' attention to problem solve in a different way.

CHAPTER III

METHODOLOGY

Introduction

This study used a quantitative approach. The rationale behind using this approach is to be able to make generalizations to a population from a sample by looking at relationships between variables (Denzin & Lincoln, 2005). The central focus of this study was to investigate whether the use of an online and interactive technological tool could be utilized in the 6th grade classroom to increase students' math performance. This study investigated if there would be any group differences on students' math performance as well as students' math anxiety, math attitudes/perceptions, and demographic characteristics.

In order to address the purpose of the study, the following research questions were examined with their corresponding hypotheses:

Q1: Will there be group differences between the experimental and control groups' math performance based on the use of an online visual and interactive technological learning tool?

It was hypothesized that there would be statistically significant differences in the math performance scores between the students that received the OVITT designed to provide students' rigorous learning through interaction and engagement for the time frame of three months and the students who did not receive the OVITT, as measured by the 2009 released 6th Grade Math TAKS test.

Q2: Will there be group differences between the experimental and control groups' math anxiety?

It was hypothesized that students who received the OVITT would have decreased math anxiety compared to the students who did not receive the OVITT, as measured by the Math Anxiety Scale-Revised.

Q3: Will there be group differences between the experimental and control groups' attitudes toward math?

It was hypothesized that students who received the OVITT would have more positive attitudes toward math compared to the students who did not receive the OVITT, as measured by the Attitudes Towards Math Inventory.

Q4: Will there be differences between experimental and control groups in math performance, math anxiety, and math attitudes compared by gender, ethnicity, and parents' education?

a) It was hypothesized that boys would score higher, white students would score higher, and students with more educated parents would score higher on the 2009 released 6th Grade Math TAKS test.

b) It was hypothesized that there would be no significant group differences on the Math Anxiety Scale-Revised and Attitudes Towards Math Inventory when compared by ethnicity and parents' education.

c) It was hypothesized that girls would score higher on the Math Anxiety Scale-Revised and would score lower on the Attitudes Towards Math Inventory.

Research Design

This study utilized a quasi-experimental design to determine group differences using pretest and post test scores of released TAKS (Texas Assessment of Knowledge and Skills) test item questions. The questions are released test item questions from 2009. In addition, the scores of the Mathematics Anxiety Scale-Revised developed by Bai (2010) and the scores of the Attitudes Toward Mathematics Inventory developed by Tapia and Marsh (2004) were used.

Demographics of Research Setting

A g*power analysis was used to determine the required sample size needed for the study (Faul, Erdfelder, Lang, & Buchner, 2007). An a priori was initially used to determine the effect sample size with a power of 0.95. However, 400 students for the sample size were not possible because that many 6th graders were not projected to enroll during the 2012-2013 school year. So a compromise power analysis based on the use of ANOVA as the statistical test was used to compute the sample size with an effect size of $f = 0.25$ (medium effect size) and estimated total sample size with two groups was 250 and a degree of freedom (df) of 10. The power results came to be 0.875 (Faul et al., 2007).

The study was conducted at a middle school that has 6th, 7th, and 8th grade students located in the North Texas area. The 6th grade students are participants enrolled in the school. The school serves a diverse population with a majority of the students who are economically disadvantaged and /or at-risk (School principal, personal communication, July 16, 2012). The school has a program that focuses on differentiated instruction that promotes an increased awareness of various world cultures, incorporation of technology, and uses other resources and tools to provide effective teaching and learning.

The participants were 6th grade students, their parents, and two 6^{th} grade teachers at the school. There are about 250-300 6^{th} graders enrolled at the middle school yearly. At the start of the study, there were 300 6^{th} grade students enrolled at the school. Based on the previous school year, the ethnic background of the 6^{th} graders consisted of about 17% of the students as African American/Black, 32% are Caucasian/White, 48% are Hispanic, 2% are of two or more races, and 2% are of another ethnic background (School counselor, personal communication, July 16, 2012). In addition, about 49% are female students and 51% are male students in the 6^{th} grade.

Sample

This study includes a sample from a middle school in the North Texas area. The middle school serves a population of students who are diverse and predominantly at-risk students. Students who are able to participate in the study had to be 6^{th} grade students at the school who provided assent along with their parents' consent.

Permission to Conduct Study

The researcher sought and received approval from the school principal and school district before submitting approval from Texas Woman's University Institutional Review Board (IRB). The principal was approached by email and in person to discuss the purpose of the research and request to conduct the study at the school. The researcher also filled out the district research application and proposal for the school district to conduct research which was approved. The students were 6^{th} grade students at a middle school located in the North Texas area. Consent forms were sent home with the potential participants that outlined the purpose and procedures of the study.

Protection of Human Rights

It is vital to protect the participants' human rights when conducting research. The research study conducted followed the guidelines provided by Texas Woman's University Institutional Review Board (IRB). Research began once the application was approved by the TWU IRB. The participants were required to have consent forms signed by their parent or guardian and signed assent and returned in order to be included in the study. Students' parents or guardians that did not agree to consent or students that did not assent still received normal classroom instruction and activity, but their information was not included in the study. All efforts were taken to ensure any potential risks are reduced. The potential risks may include loss of time and loss of confidentiality. Loss of time may occur due to the intervention occurring during a class period. Within this risk, the researcher as a teacher continued to follow the scope of sequence and teaching the students all the state standards they are supposed to learn for their grade level. In addition, loss of confidentiality was a possible risk. However, this was reduced due to the researcher and the advisor being the only people with access to the information gathered. The data is locked in the researcher's file cabinet. Furthermore, the information gathered such as the tests and the survey forms have an assigned ID number and will be shredded within five years after the study is finished.

Measures

Demographic Information Forms

The 6th grade students were given demographic information forms as part of their consent packet (see Appendix C and D). The demographic form was designed to acquire information regarding the students' personal and family demographics such as gender of student, ethnicity of student, age of student, language spoken at home, relationship of the person filling out the form to the student, education of students' mother and father, and household income. The form was available in English and Spanish.

Independent Variables

The independent variables used in the study are listed below. Some of the independent variables were obtained from the demographic forms that the student and their families received with their consent forms. The variables obtained from the form that were used in the study were: gender of the student, ethnicity of the student, and mother's educational level.

Gender. The 6th grade participants indicated whether they were male or female on the demographic information form (see item 1 on the demographic form). The student participants were coded in the research 1=Males and 2=Females.

Ethnicity. The 6th grade participants indicated whether they were Hispanic or Latino, American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, White, Biracial or Other and to specify on the last two choices (see item 2 on the Demographic Information Form). The students' ethnicity were re-coded in the research as 1=Hispanic, 4=Black, 6=White, and 9=Others. These categories were collapsed from eight to four because there was not enough number of participants who were American Indian or Alaska Native, Asian, Native Hawaiian or Other Pacific Islander, Biracial or Other. So these ethnic groups made up the fourth ethnic group category of "Others".

Mother's educational level. The 6th grade participants and/or their parent filling out the form with them indicated their mother's level of education ranging from early school to an earned doctorate. This was used to represent the socioeconomic status of the students because there was not enough information regarding the father's educational level. The students' mother's education were re-coded in the research as 1= "high school or less" and 2="college+" because about half of the mothers had a high school education or less and the other half of the mothers had some type of college education.

Tgroup. This independent variable represents the two groups of students in the study, experimental group and control group. The experimental group received the online visual, interactive technology tool known as Brainingcamp. Tgroup was coded as 1=Experimental and 2=Control.

Dependent Variables

This study investigated the relationship of the above mentioned independent variables with the following dependent variables: scores from students' math anxiety, scores from students' attitudes towards math, and scores from students' math performance. Students' scores were obtained during the pretest, before the experimentation, and the posttest, after the 3 month experimentation of Brainingcamp.

Instrument I: Mathematics Anxiety Scale –Revised (MAS-R). The Mathematics Anxiety Scale –Revised (MAS-R) was developed by Bai (2010). The math anxiety instrument is a 5-point Likert scale which has 14 items using "not true" (1), slightly true, moderately true, mostly true or "very true" (5). This scale contains positive and negative subscales that were determined by factor analysis. For example, there are questions such as, "I find math interesting" and, "Mathematics makes me feel nervous" that represent positive and negative attitudes. Each subscale is made up of seven items. This instrument was validated with two independent samples consisting of 647 secondary school students (Bai, 2010). Construct validity was strong based on literature reviews and the judgment of experts. Bai (2010) reported that the internal consistency of the instrument was 0.85, test-retest reliability was 0.71, and interfactor correlation was 0.26 with $p < 0.001$. Positive discrimination revealed that the MAS-R was a reliable and valid measure for measuring mathematics anxiety. Bai (2010) further recommended that this tool might be a beneficial instrument for classroom teachers and other scholars to detect and determine students who might be at risk of reduced math achievement due to anxiety.

The students in the experimental and control groups completed the MAS-R. Students provided their ID number and date at the top of the survey. Students were given a class period to complete the 14-item survey in conjunction with the other surveys/questionnaires and return it to their teacher.

Instrument II: Attitudes Toward Mathematics Inventory (ATMI). The Attitudes Toward Mathematics Inventory was developed by Tapia and Marsh (2004). The purpose of its development was to provide an updated tool to measure students' math attitudes. It investigates various dimensions of attitudes students have towards math. It is a 49-item instrument that was developed to assess confidence, anxiety, value, enjoyment, motivation, and parent/teacher expectations. This math attitudes instrument uses a 5-point Likert scale with (1) as strongly disagree, (2) disagree, (3) neutral, (4) agree, and (5) as strongly agree. Some questions include: "mathematics is a very worthwhile and necessary subject"; "mathematics makes me feel uncomfortable"; "I would like to avoid using mathematics in college" (Tapia & Marsh, 2004). This instrument was validated with a sample of 545 high school students who were in a math class. The high school students consisted of 135 freshmen, 153 sophomores, 168 juniors, 84 seniors, and five 8th-grade students (Tapia & Marsh, 2004). The scale contains 12 items that were reverse scored in order to provide the appropriate value for data analysis. Tapia and Marsh (2004) reported the internal consistency of the scores with the use of Cronbach alpha to be 0.96.

Construct validity was established based on literature reviews and the judgment of experts (Tapia & Marsh, 2004). In addition, it was noted that 40 of the 49 items had item-to-total correlations above 0.50, with the highest at 0.82. With revision, the inventory had an alpha value of 0.97, a mean of 137.36, a standard deviation of 28.93, and a standard error of measurement of 5.28 (Tapia & Marsh, 2004). A factor analysis was used with four factors retained: self-confidence, value, enjoyment and motivation. The researchers also used the Pearson correlation coefficient for test-retest reliability. It was conducted with a follow-up after the three months of the study with the 40-item inventory that was administered to the 64 students who had previously taken the survey. The researchers also conducted a test-retest that yielded a score with a coefficient of 0.89, and coefficients for the subscales were: Self-confidence 0.88; Value 0.70; Enjoyment 0.84; and Motivation .78 (Tapia & Marsh, 2004). The data indicates that the scores on the inventory and the subscales are stable over time. Furthermore, researchers reported this instrument was able to delve into important aspects of math attitudes in addition to being valid and reliable to better understand students' attitudes towards math in other grade levels.

The students in the experimental and control groups completed the MAS-R. Students provided their ID number and date at the top of the survey. Students were given a class period to complete the 40-item survey in conjunction with the other surveys/questionnaires and return it to their teacher.

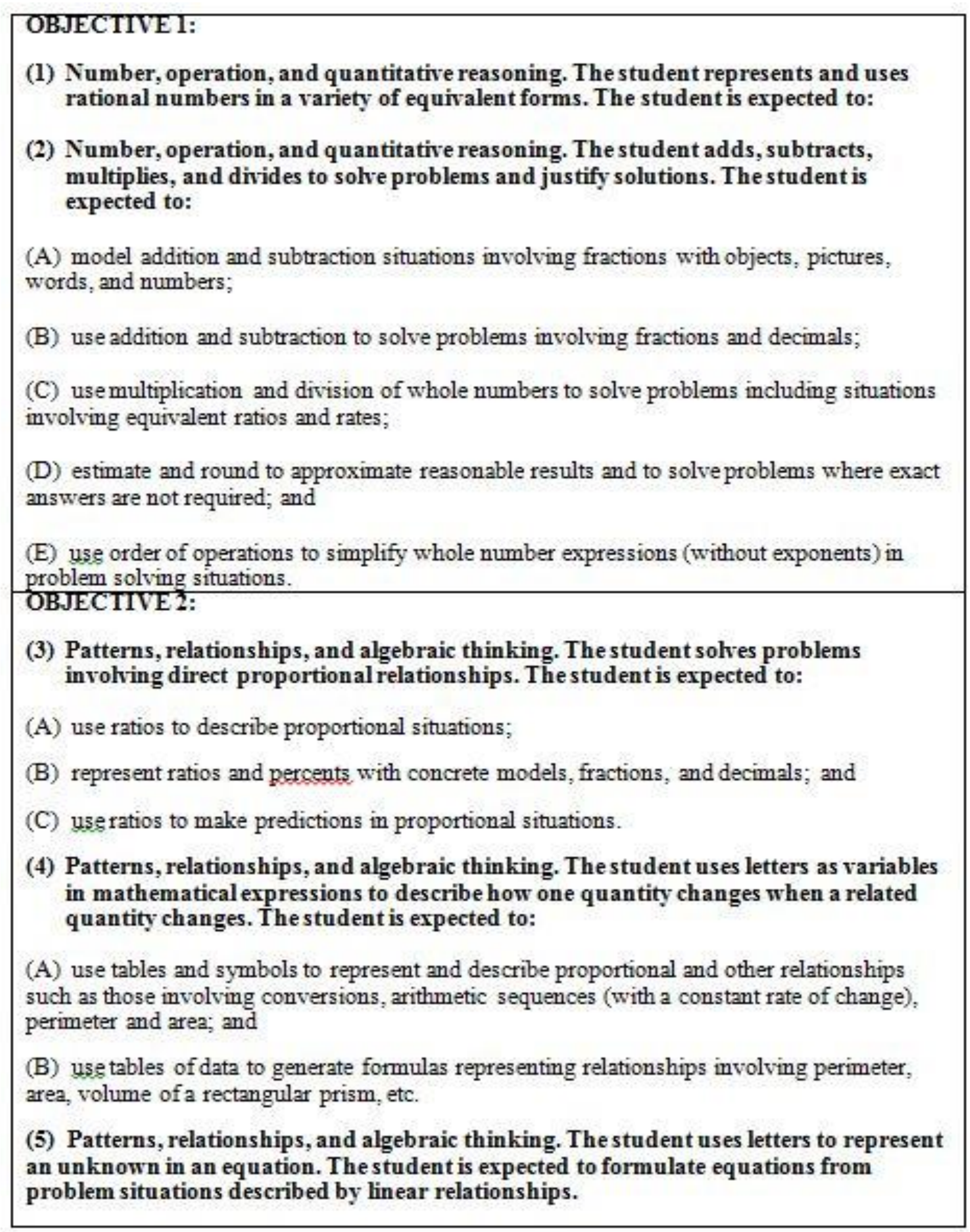
Instrument III: 2009 Texas Assessment of Knowledge and Skills (TAKS) released test items. Texas Assessment of Knowledge and Skills (TAKS) is the standardized form of assessment used in Texas to assess students' knowledge and skills in contents such as math, science, social studies, reading, and writing (Texas Education Agency, 2009). It is usually administered to students in grades three throughout high school in the spring semester. Testing in Texas has grown and changed over time. In 1979, Texas decided to have statewide testing (Texas Education Agency, 2009). The goal has been to provide an assessment that can accurately provide information on performance as well as hold the school and district accountable for the state standards. In the past, testing was focused on the basic, minimum standards (Texas Education Agency, 2009). The state test in Texas has improved over time to not only test math basic skills, but also math problem solving skills.

Many of the changes were due to legislation and policy. As the policies have changed, the level of assessment has increased in "size, scope, and rigor" (Texas Education Agency, 2009, p. 2). TAKS replaced TAAS, Texas Assessment of Academic Skills, in the 2002-2003 school year, to provide an assessment that was more than the assessment of basic skills, but more comprehensive as well. The most recent change has occurred in the 2011-2012 school year with a transition from TAKS to STAAR. It is said to be more rigorous and focused on college readiness standards in conjunction with the state standards (Texas Education Agency, 2011).

TEA has formed new partnerships, for instance with Pearson, in verifying the accuracy of the data. Texas has been able to provide test scores that are reliable and valid due to the state's experience in standardized testing (Texas Education Agency, 2009). The reliability for the TAKS test ranges from 0.87 to 0.90 (Texas Education Agency, 2007). Content validity of TAKS is based on its test design and when it is reviewed by a panel of testing experts (Texas Education Agency, 2007). TAKS is a standards-referenced assessment that has been reviewed by multiple committees of educators that examine the test items in order to uniformly determine the test items that appropriately assess the knowledge and skills the students are to learn for their respective grade level and content (Texas Education Agency, 2007). Criterion-related validity is established when the state compares the performance of the students in Texas to other students nationally. Construct validity is also ensured by comparing the results to studies that are published regarding progress standards (Texas Education Agency, 2007).

TEA releases test items from previous tests occasionally (Texas Education Agency, 2011). The release test items can be used in the classroom to assess students on various math topics learned in class (see http://www.tea.state.tx.us/student.assessment/taks/released-tests/archive/). Although there has been a change in the testing program, there will not be released test items for STAAR in the meantime. The 2009 6th grade math questions are aligned with the TEKS, Texas Essential Knowledge and Skills. Students will be tested on Objectives 1, and 6 which are Number, Operations, and Quantitative Reasoning; Patterns, Relationships, and Algebraic

Thinking; and Underlying Process and Mathematical Tools respectively (Texas Education Agency, 2009, §111.22. Mathematics, Grade 6). A list of the TEKS by objectives for this study is represented in Figure 1.



OBJECTIVE 1:

(1) Number, operation, and quantitative reasoning. The student represents and uses rational numbers in a variety of equivalent forms. The student is expected to:

(2) Number, operation, and quantitative reasoning. The student adds, subtracts, multiplies, and divides to solve problems and justify solutions. The student is expected to:

(A) model addition and subtraction situations involving fractions with objects, pictures, words, and numbers;

(B) use addition and subtraction to solve problems involving fractions and decimals;

(C) use multiplication and division of whole numbers to solve problems including situations involving equivalent ratios and rates;

(D) estimate and round to approximate reasonable results and to solve problems where exact answers are not required; and

(E) use order of operations to simplify whole number expressions (without exponents) in problem solving situations.

OBJECTIVE 2:

(3) Patterns, relationships, and algebraic thinking. The student solves problems involving direct proportional relationships. The student is expected to:

(A) use ratios to describe proportional situations;

(B) represent ratios and percents with concrete models, fractions, and decimals; and

(C) use ratios to make predictions in proportional situations.

(4) Patterns, relationships, and algebraic thinking. The student uses letters as variables in mathematical expressions to describe how one quantity changes when a related quantity changes. The student is expected to:

(A) use tables and symbols to represent and describe proportional and other relationships such as those involving conversions, arithmetic sequences (with a constant rate of change), perimeter and area; and

(B) use tables of data to generate formulas representing relationships involving perimeter, area, volume of a rectangular prism, etc.

(5) Patterns, relationships, and algebraic thinking. The student uses letters to represent an unknown in an equation. The student is expected to formulate equations from problem situations described by linear relationships.

OBJECTIVE 5:

(10) Probability and statistics. The student uses statistical representations to analyze data. The student is expected to:

(A) select and use an appropriate representation for presenting and displaying different graphical representations of the same data including line plot, line graph, bar graph, and stem and leaf plot;

(B) identify mean (using concrete objects and pictorial models), median, mode, and range of a set of data;

(C) sketch circle graphs to display data; and

(D) solve problems by collecting, organizing, displaying, and interpreting data.

OBJECTIVE 6:

(11) Underlying processes and mathematical tools. The student applies Grade 6 mathematics to solve problems connected to everyday experiences, investigations in other disciplines, and activities in and outside of school. The student is expected to:

(A) identify and apply mathematics to everyday experiences, to activities in and outside of school, with other disciplines, and with other mathematical topics;

(B) use a problem-solving model that incorporates understanding the problem, making a plan, carrying out the plan, and evaluating the solution for reasonableness;

(C) select or develop an appropriate problem-solving strategy from a variety of different types, including drawing a picture, looking for a pattern, systematic guessing and checking, acting it out, making a table, working a simpler problem, or working backwards to solve a problem; and

(D) select tools such as real objects, manipulatives, paper/pencil, and technology or techniques such as mental math, estimation, and number sense to solve problems.

(12) Underlying processes and mathematical tools. The student communicates about Grade 6 mathematics through informal and mathematical language, representations, and models. The student is expected to:

(A) communicate mathematical ideas using language, efficient tools, appropriate units, and graphical, numerical, physical, or algebraic mathematical models; and

(B) evaluate the effectiveness of different representations to communicate ideas.

(13) Underlying processes and mathematical tools. The student uses logical reasoning to make conjectures and verify conclusions. The student is expected to:

(A) make conjectures from patterns or sets of examples and nonexamples; and

(B) validate his/her conclusions using mathematical properties and relationships.

Figure 1. TEKS by objectives.

Both groups took the test at the beginning and at the ending of the study. Students were tested on these objectives because the math concepts were taught based on those objectives from October 2012 through January 2013. Some items assessed students' basic math skills, for instance, Figure 2:

A teacher has 32 students in her class. She wants to put the students into groups so that each group has the same number of students. Which of the following does NOT represent the number of students she could put into groups?

A 4

B 10

C 8

D 16

Figure 2. Example question on students' basic math skills.

Other questions were more complex and/or required multiple steps to solve the problem such as Figure 3.

Janette has a spinner with 8 equal sections. Each section is labeled red, green, or yellow. What additional information is needed to find the probability of the arrow landing on a red section on the next spin?

F The radius of the spinner

G The circumference of the spinner

H The number of times Janette has landed

on a green section

J The number of sections of each color

Figure 3. Example question on students' problem solving math skills.

The students' math performance was measured with the 33 questions, total scale. Ten questions came from Objective 1, nine from Objective 2, five from Objective 5, and nine from Objective 6. Objective 6 consisted of the problem solving questions. The percents are based on the total number of questions correct out of the total number of questions presented. The change from the pretest to posttest was represented as a positive or negative gain. In addition, there are subscales to show students' performance overall as well as based on the specific objectives, Objective 1, 2, 5, and 6. At the pretest level, students did not know all the content provided, but by the posttest level all concepts had been taught.

Brainingcamp Questionnaire

About a week after the posttests, students in the experimental group were given a questionnaire to respond to regarding their experience with Brainingcamp. There were eight statements and an opened-ended question at the end to allow students to discuss their experience with Brainingcamp and whether or not it was helpful to their learning. The eight questions were statements given to the students to agree or disagree with. For example, they could agree or disagree on if they were motivated in their learning through the use of a computer.

Intervention

The intervention for the experimental group was the use of the Brainingcamp program. Brainingcamp is an educational math software for 6^{th} through 8^{th} grade founded by Dan Harris (Brainingcamp, 2010). Brainingcamp is an online visual and interactive technological tool that provides visual lessons, interactive virtual manipulatives, automated student assessment, fun real world problem solving, designed to correlate with various state standards, including Texas state standards (Brainingcamp, 2010). Brainingcamp can be used with whole classes or individual students for the introduction of a new topic, review, or providing a way to help students to understand abstract concepts in a more concrete manner (Brainingcamp, 2010). It is beneficial in providing students with rigorous learning because it more than rote memorization, rather it is interactive and engaging to help students connect and apply math concepts efficiently. In addition, the real world connections provide a motivation for students because they can relate to the presented information. Figure 4 is an example of how a full layout of all the lessons on Brainingcamp begins.

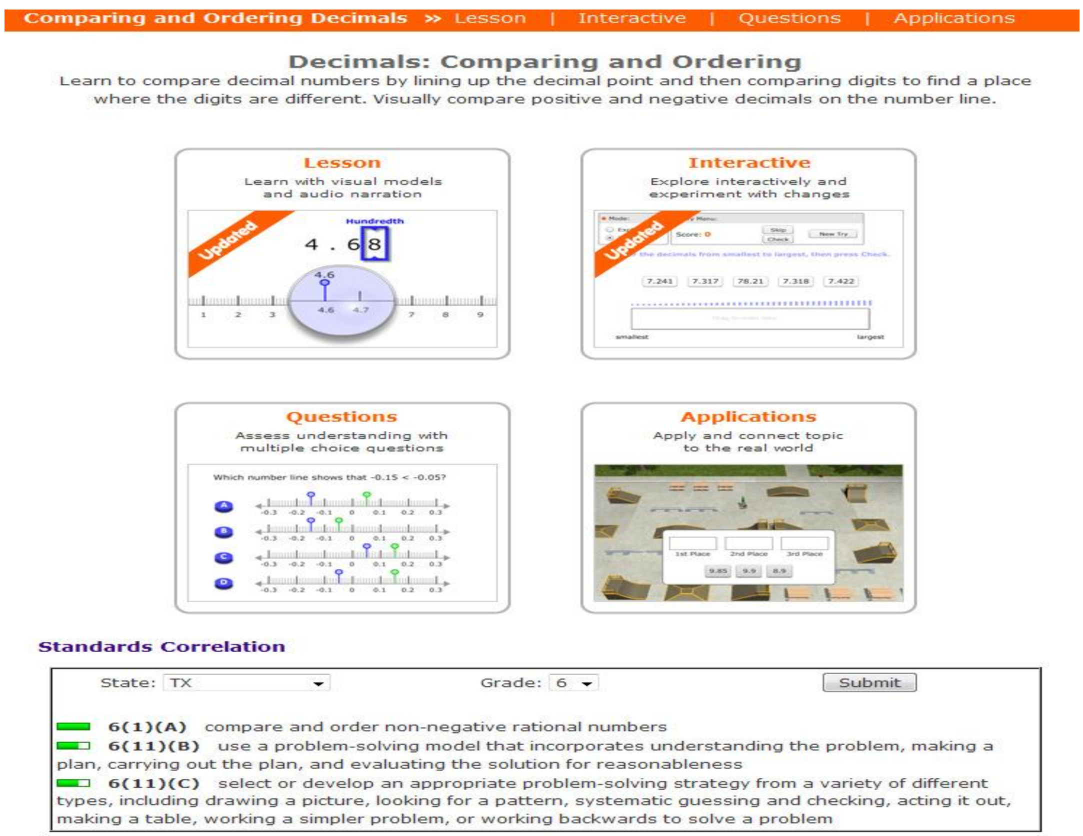


Figure 4. Example of Brainingcamp lesson layout.

This particular lesson correlated with the math topic of comparing and ordering decimals within Objective #1 of the TEKS. Students would begin by going through the lesson introduction. During the introduction section, students are spoken to and provided with the text to follow along. After an explanation and step-by-step instructions are provided of how to order and compare decimals, students would work on the interactive process with decimals. With understanding and practice, students are expected to be able to answer questions to assess their understanding and finally connect the concept to the real world (Brainingcamp, 2010). The process of the lesson begins with some direct instruction to concrete learning, then to pictorial learning and concluding with abstract thinking and application. This process of learning also happens in the classroom so students have more exposure to the learning process, but with the added tool through the use of the program.

Brainingcamp lends itself to support various learning styles and help students learn how to be critical thinkers through analyzing, synthesizing, thinking, and explaining their math learning (Brainingcamp, 2010). At the conclusion of the study the control group will use Brainingcamp or similar programs in the same setting.

Additional instruction is provided either before or after participating in the Brainingcamp program. The classes are set up as a partial block schedule with all classes held for 45 minutes on Mondays (A-day), Tuesday/Thursday are B-days, Wednesday/Friday are C-days, and the 1st period math class meets daily for 45 minutes. Students come into the classroom and work on their Bellwork assignment that may be on a piece of paper or on the overhead pertaining to old, current, and some new information they have been learning or soon to learn.

Students are presented with new information or review previously learned information as a class, in groups or partnerships, and individually depending on the math topic. Introduction of a topic could go through a process of engaging the students in what they will be learning with a hands-on activity where discovery of the topic may occur and then lead into the explaining of the new topic through interactive notes and examples on the board or overhead. After this process, then the students in the experimental group will logon to Brainingcamp and begin the process of going through the Lesson section of the topic and take notes, then to the last three sections Interactive, Questions, and Applications in that order.

Both groups received the same instruction on the math topics. Various instructional strategies such as differentiated instruction, collaborative grouping, independent work, think-pair-share, whole class instruction, the use of manipulatives, writing in their math journals, and other strategies that are regularly used in the classroom were used to teach the students their state, grade level standards.

Experimental and Control Treatments

All the students were entered into the school system with a schedule software program used by the school district, Gradespeed, prior to the start of the school year. Once the students were entered into the system, the school counselors entered parameters for the system to group students. The parameters were special education, gifted/talented, LEP (Limited English Proficiency), gender, race/ethnicity, and SES. Since there are two teams per grade level, for example Team 6-1 and Team 6-2 for 6th grade, the system divided the students based on the parameters entered into two equal groups (School counselor, personal communication, July 13, 2012). Within each team, there was a teacher for each of the core contents: math, science, reading, social studies/history, and English. To ensure the occurrence of the intervention, the researcher served as the classroom teacher for the experimental group and the other 6th grade math teacher taught the other half of the 6th graders to represent the control group.

The students in the experimental group received the Brainingcamp intervention in addition to their regular classroom activities. The students used small laptops or classroom computers that were in the classroom twice a week for 30-45 minutes beginning in October through January. The students signed a sign-in sheet for every time they used Brainingcamp. The sign-in sheet included the students' name, the date, start time, and end time. This was done to show fidelity of their use of Brainingcamp since there was not a way to record their time within the program. The student participants became immediately familiar with the program during one 30-minute session prior to using the program. The teacher browsed through the program and set up the student accounts a month prior to the students using the program. Students worked through visual lessons that introduced and explained concepts related to what they were currently learning in the classroom. The lessons were aligned with the state standards. Students were engaged in the use of interactive virtual manipulatives of the program to help students understand abstract concepts concretely. Problem solving was addressed through the use of engaging and relatable problems to motivate and challenge the students as well as connect math to their everyday life activities. Students worked individually when on the computers with teacher assistance or from a classmate who was at their table as needed.

Data Collection

The 6th grade math teachers informed the 6th grade students of the research study and sent home envelopes containing the consent forms and Demographic Information Forms during the week of October 15th. Participants were asked to return the signed consent forms and demographic forms in a sealed envelope by the week of October 22nd. The consent forms and family demographic information forms were available in English and in Spanish.

Due to the request of family information about the students' parents and family, the parents were also considered as participants. The parental involvement was limited to completing the Demographic Information Form only. They completed the form after they read about the study and signed the consent form. Students who were considered participants in the research study were those whose parents/guardians provided consent and the students provided assent. Only the data pertaining to these students was analyzed for this research study.

Instruction

As part of normal classroom activities, every 6th grade student received regular math instruction time for 45 minutes on Mondays and 90 minutes each day on Tuesday through Friday. The research study was conducted during class time from October 2012 to January 2013. Math instruction was planned during a scheduled conference between each 6th grade math teacher weekly. The math teachers planned their instruction based on the same math concepts following the 6th grade math Texas Essential Knowledge and Skills (TEKS), in a lesson plan format (Appendix H), using similar teaching strategies, including group activities, individual work, think-pair-share (partners), and the use of manipulatives. All of these were part of normal classroom activities.

As a way of testing the efficacy of Brainingcamp, students were either in the experimental group or control group. Class rosters for each teacher were printed and ID numbers were assigned to each student. Attendance was recorded daily according to district school policies. All students were involved in the same activities, except for the experimental group who received the Brainingcamp program on computers for 30-45 minutes, twice a week during their regularly scheduled instructional time.

Pretests

As per normal procedures for all 6th grade math teachers, pretests were given to all students in October. The released items from the 2009 Texas Assessment of Knowledge and Skills (TAKS) math test was administered to the 6th grade students to assess their math performance. The time necessary to complete the TAKS measures was one class session of 90 minutes each for the pretest and posttest. Teacher-facilitated student assessments also administered was the Math Anxiety Scale Revised (MAS-R) that assessed student math anxiety and the Attitudes Towards Math Inventory (ATMI) that assessed students' attitudes towards math. The time necessary to complete both the MAS-R and ATMI measures was one class session of 90 minutes for the pretest and posttest. Students who were not present the day of the pretest were allowed to take the pretest upon their return.

Post-tests

All the student participants were given the same surveys form the pretest to take again as a post-test in January. The students received the same amount of time given during the pretest for the posttest. Students who were not present the day of the posttest were allowed to take it the day they returned.

Data Analysis

This study investigated whether students in the experimental group who received the Brainingcamp program would perform differently based on their math performance, math anxiety, and attitudes toward math compared to the control group. The statistical analysis used for the study was the IBM SPSS 21 software.

The Demographic Information Form was analyzed by running frequencies and percentages to provide the number of participants in the study overall and participants represented for each question on the Demographic Information Form.

Research Question One was answered by analyzing the 2009 TAKS test. A one-way analysis of covariance (ANCOVA) was conducted to examine a possible difference in the math performance, 2009 TAKS total percent posttest scores, of students who received Brainingcamp and students who did not receive Brainingcamp. The 2009 TAKS total percent pretest scores were used as the covariate to adjust for any variations in the students' ability prior to the start of Brainingcamp. An ANCOVA was chosen as the statistical test for the data because it evaluated the mean differences of the dependent variable while controlling for the covariate variable that may influence the dependent variable (Mertler & Vannatta, 2010). The subscales for the 2009 TAKS test were Objective 1, 2, 5, and 6. Sample sizes, means, and standard deviations were calculated for each item.

Research Question Two was answered by analyzing the MAS-R. This was also done for the analysis between the experimental and control group on their math anxiety Positive and Negative subscale scores. An ANCOVA was also used. Sample sizes, means, and standard deviations were calculated for each item.

Research Question Three was answered by analyzing the total score of the ATMI to measure students' attitudes toward math using an ANCOVA. The subscales were self-confidence, value, enjoyment, and motivation and the pretest was used as the covariate. The scale contains 12 items that were reverse scored in order to provide the appropriate value for data analysis. Sample sizes, means, and standard deviations were calculated for each item.

Research Question Four was answered by analyzing the 2009 TAKS test by gender, ethnicity and mothers' education using a Factorial ANCOVA, the MAS-R by gender, ethnicity, and mothers' education using a Factorial ANCOVA, and the ATMI by gender, ethnicity, and mothers' education using a Factorial ANCOVA. Sample sizes, means, and standard deviations were calculated for each item.

The Brainingcamp Questionnaire was analyzed by running frequencies and percentages to provide information on the experimental groups' responses to the 8 items and their individual open-ended responses on Question #9.

Summary

This study was conducted with 6th grade students at a middle school in the North Texas area from October 2012 to January 2013. Students were divided into experimental and control group received their regular math instruction, however, the experimental group received the use of Brainingcamp, an online visual interactive technological tool. Pretests were given prior to the intervention for their math performance, math anxiety, and math attitudes. At the end of January, students took the pretests were gathered and entered into SPSS to be analyzed. Students in the experimental group completed a questionnaire regarding their experience with Brainingcamp about a week after their completion of the posttests. The data was analyzed and the results of the study are presented in the following chapter.

CHAPTER IV

RESULTS

Introduction

The purpose of this study was to examine whether students in the experimental group, those who received the online, visual, interactive technological tool performed differently in comparison to the control group on their math performance. This study also further attempted to examine the effects of the program on students' math anxiety and attitudes towards math. In order to evaluate the effectiveness of Brainingcamp, this study tried to determine the differences between the experimental and control group based on ethnicity, gender, and mothers' education of the 6^{th} grade students during the time period of three months.

The data collected for this study was entered and analyzed using SPSS, a computer program for statistical analysis. The report of the findings of the study is discussed below in the following order: demographic information of the participants, data analysis and results of each research question, and summary of the results.

Data Analyses

Once approval was obtained from the Texas Woman's University IRB, consent forms and Demographic Information forms were provided to the 6^{th} graders in the experimental and control group at the middle school in a sealed brown envelope. All forms were completed, signed, and returned by 155 parents. The Demographic Information Form contained seven questions that described the family demographics.

Interpretation of Data

Demographic Information Form

Based on the demographic forms returned to school with the consent forms, there were 155 6th grade student participants (98 participants in the experimental group and 57 participants in the control group). This information was entered in the IBM SPSS 21 software. The frequencies were run to provide the number of participants in the study overall and participants represented for each question on the Demographic Information Form. The experimental group contained 42.9% male and 57.1% female students. The ethnicity breakdown from the demographic forms for the experimental group was 37.8% Hispanic or Latino, 1% American Indian or Alaska Native, 1% Asian, 14.3% Black or African American, 31.6% White, 13.3% Biracial, and 1% Other ethnic background. Students were between the ages of 10 years and 3 months (123 months) and 13 years (156 months). There was a variance of who filled out the demographic forms of the students. The mothers were the majority who filled out the forms with 84.7% for the experimental group.

The education levels of the students' mother's (n=91) and father's education (n=76) varied as well. Parents of the students in the experimental group reported their education from early schooling to obtaining a Doctoral degree. The mother's education from early school to 5th grade education was 3.3%, middle school (6th-8th grade) education was 13.2%, high school (9^{th}-12^{th} grade) education was 11%, 12^{th} grade with no diploma was 3.3%, and high school graduate or equivalent was 19.8%. This group of mothers totaled about half of the mothers in the experimental group (50.5%). The remaining half of the mothers (49.5%) had some college education and higher. The father's education was also based on the same level of education from early school to Doctoral degree. The father's education from early school to 5^{th} grade education was 2.6%, middle school (6^{th}-8^{th} grade) education was 11.8%, high school (9^{th}-12^{th} grade) education was 19.7%, 12^{th} grade with no diploma was 1.3%, and high school graduate or equivalent was 23.7%. This group of fathers totaled more than half of the fathers in the experimental group (59.2%). The remaining fathers (40.8%) had some college education and higher. Fathers with less than 1 year college credit was 7.9%, one or more years of college credit, without a degree was 9.2%, Associate degree was 2.6%, Bachelor's degree was 7.9%, Master's degree was 7.9%, Professional degree (MD, JD) was 3.9%, and Doctorate degree (PhD, EdD) was 1.3%. The majority of the students' families earned low household incomes. There were 29.9% of the parents that reported having a household income of $40,000 or more (n=87).

The control group contained similar demographics. There were 47.4% male and 52.6% female students who were between the ages of 10 years 8 months (128 months) and 12 years and 4 months (148 months) at the start of the study (n=51). The language spoken at home (n=56) was mostly English which was similar to the experimental group with 62.5%. Some families mostly spoke Spanish at home (25%) or spoke English and

Spanish at home (12.5%). The ethnic breakdown of the students in the control group was 46.4% Hispanic or Latino, 1.8% Native Hawaiian or other pacific islander, 14.3% Black or African American, 23.2% White, 12.5% Biracial, and 1.8% Other ethnic background (n=56). The control group had either the mother or father who filled out the demographic form with 85.7% and 14.3% respectfully.

Parents of the students in the control group reported their education from early school to Doctoral degree. The mother's education of the students' in the control group contained 15.1% of mothers with middle school education, 15.1% with high school education, 5.7% with 12th grade and no diploma, and 26.4% with less than one year college credit. The remaining education levels of the mothers in the control group were 37.7% with some college credit to a Master's degree (n=53). The father's education levels varied as well. The father's education level was more than half (57.8%) from early school through high school graduate or equivalent with a majority of the educational level in that group at 24.4% high school graduate. Fathers of the control group participants had 15.6% with one or more years of college credit with no degree, fathers with an Associate degree was 6.7%, Bachelor's degree was 11.1%, Master's degree and Doctorate degree each were 4.4% of the fathers in the control group (N=45). The household income of the control group was 60.4% with a household income of $29,999 or less and 39.6% with $30,000 or more (N=53). Below is a table of the demographic information of the student participants.

Table 1

Gender and Ethnicity of Experimental and Control Groups

	Experimental		Control	
	f	%	*f*	%
Gender	98	100.0	57	100.0
Male	42	42.9	27	47.4
Female	56	57.1	30	52.6
Ethnicity	98	100.0	56	100.0
Hispanic/Latino	37	37.8	26	46.4
American Indian or Alaska Native	1	1.0	0	0.0
Native Hawaiian or Other Pacific Islander	0	0.0	1	1.8
Asian	1	1.0	0	0.0
Black or African American	14	14.3	8	14.3
White	31	31.6	13	23.2
Biracial	13	13.3	7	12.5
Other	1	1.0	1	1.8

Table 2

Age in Months of Both Groups

	n	*M*	*SD*	*Min*	*Max*
Experimental	91	137.49	4.67	123	156
Control	51	137.73	4.42	128	148

Table 3

Language Spoken at Home and Relationship to the Student of Both Groups

	Experimental Group		Control Group	
	f	%	*f*	%
Languages spoken at home	98	100.0	56	100.0
Mostly English	63	64.3	35	62.5
Mostly Spanish	19	19.4	14	25.0
English and Spanish	12	12.2	7	12.5
Other Languages	1	1.0	0	0.0
English and another language	3	3.1	0	0.0
Relationship to student	98	100.0	56	100.0
Mother	83	84.7	48	85.7
Father	12	12.2	8	14.3
Grandmother	2	2.0	0	0.0
Other Guardian	1	1.0	0	0.0

Table 4

Mother's and Father's Education of Both Groups

	Experimental Group		Control Group	
	f	%	*f*	%
Mother's Education	91	100.0	53	100.0
Early school to 5th grade	3	3.3	0	0.0
Middle school (6th-8th grade)	12	13.2	8	15.1
High school (9th-12th grade)	10	11.0	8	15.1
12th grade, no diploma	3	3.3	3	5.7
High school graduate -high school diploma or GED	18	19.8	14	26.4
Some college credit, but less than 1 year	5	5.5	2	3.8
1 or more years of college, no degree	15	16.5	6	11.3
Associate degree (for example: AA, AS)	4	4.4	3	5.7
Bachelor's degree (for example: BA, AB, BS)	13	14.3	4	7.5
Master's degree (examples: MA, MS, MEd, MBA, etc.)	5	5.5	5	9.4
Professional degree (for example: MD, DDS, DVM, JD)	1	1.1	0	0.0
Doctorate degree (for example: PhD, EdD)	2	2.2	0	0.0
Father's Education	76	100.0	45	100.0
Early school to 5th grade	2	2.6	1	2.2
Middle school (6th-8th grade)	9	11.8	5	11.1
High school (9th-12th grade)	15	19.7	7	15.6
12th grade, no diploma	1	1.3	2	4.4
High school graduate - high school diploma or GED	18	23.7	11	24.4
Some college credit, but less than 1 year	6	7.9	0	0.0
1 or more years of college, no degree	7	9.2	7	15.6

(Continued)

Associate degree (for example: AA, AS)	2	2.6	3	6.7
Bachelor's degree (for example: BA, AB, BS)	6	7.9	5	11.1
Master's degree (examples: MA, MS, MEd, MBA)	6	7.9	2	4.4
Professional degree (for example: MD, DDS, DVM, JD)	3	3.9	0	0.0
Doctorate degree (for example: PhD, EdD)	1	1.3	2	4.4

Table 5

Household Income of Both Groups

	Experimental Group		Control Group	
	f	%	*f*	%
Household Income	87	100.0	53	100.0
Less than $10,000	18	20.7	9	17.0
$10,000 to $19,999	17	19.5	11	20.8
$20,000 to $29,999	11	12.6	12	22.6
$30,000 to $39,999	15	17.2	4	7.5
$40,000 to $49,999	7	8.0	5	9.4
$50,000 to $59,999	4	4.6	2	3.8
$60,000 to $69,999	3	3.4	2	3.8
$70,000 to $79,999	3	3.4	2	3.8
$80,000 to $89,999	2	2.3	2	3.8
$90,000 to $99,999	0	0.0	1	1.9
$100,000 or more	7	8.0	3	5.7

Research Questions and Hypotheses

This research study examined the impact of Brainingcamp on 6th students' math performance, math anxiety, and math attitudes. The researcher also examined differences based on ethnicity, gender, and mothers' educational background on these three measures. Students in the experimental group also answered a questionnaire posed by the researcher to gauge their thoughts on their Brainingcamp experience.

Results: Students' Math Performance

Research Question One: Will there be group differences between the experimental and control groups' math performance based on the use of an online visual and interactive technological learning tool?

Hypothesis 1: It was hypothesized that there would be statistically significant differences in the math performance scores between the students that received the OVITT designed to provide students' rigorous learning through interaction and engagement for the time frame of three months and the students who did not receive the OVITT, as measured by the 2009 released 6^{th} Grade Math TAKS test.

Math performance is a student's ability to display proficiency of math through the application of the content in various situations such as analytically and in the real world (National Center for Education Statistics, 2009). The 2009 Texas Assessment of Knowledge and Skills test was the instrument used to measure students' math performance in the study. Students who received the Brainingcamp intervention were the experimental group and students who did not receive the intervention were the control group. The results of the analyses are presented comparing the experimental and control groups.

An ANCOVA was conducted to determine if there was a statistically significant difference on the overall TAKS performance percent total scores between the experimental and control groups. The percent total scores represent the percentage of correct responses to the TAKS items. The posttests of the TAKS performance percent total scores were the dependent variables while the pretests of the TAKS performance percent total scores served as the covariates. The sample sizes, means, and standard deviations are shown in Table 6. A graph of the experimental and control group means are presented in Figure 1. There was no statistically significant difference between the experimental and control group on their posttest scores, $F(1, 131) = 0.015$, $p = 0.904$. Although there were no significant differences between groups, there was an increase of math performance scores from pretest to posttest for both groups of students with the control group scoring slightly higher.

Table 6

Means and Standard Deviations for Percent Total TAKS Scores

TAKS Total Scale		Pretests		Posttests	
	n	*M*	*SD*	*M*	*SD*
Experimental Group	90	0.45	0.21	0.66	0.22
Control Group	44	0.47	0.22	0.68	0.20

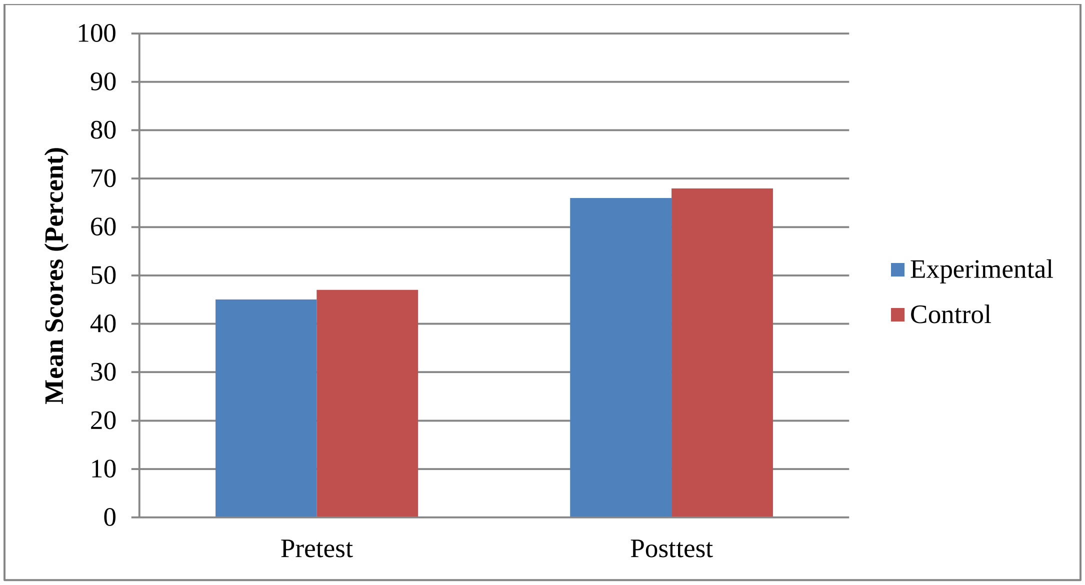


Figure 5. Pretest and posttest mean percent scores for the overall test.

There were four objectives 1, 2, 5, and 6 that comprised the TAKS total for this study. Objective 1 is Numbers, Operations and Quantitative Reasoning, Objective 2 is Patterns, Relationships and Algebraic Reasoning, Objective 5 is Probability and Statistics, and Objective 6 is Mathematical Processes and Tools. The objectives were subscales of the test and a correlation matrix was conducted to check for possible correlations. Since the subscales correlated with one another, a MANCOVA was conducted with the posttests of the individual objectives as the dependent variables and the pretests of each objective as the covariates. Table 7 provides the sample sizes, means, and standard deviations of the TAKS subscales for both groups. Table 8 provides the correlations of the subscales.

Table 7

Means and Standard Deviations for TAKS Subscale Scores

TAKS Subscales		Pretests		Posttests	
	n	*M*	*SD*	*M*	*SD*
Experimental Group					
TEKS Obj 1	91	0.45	0.26	0.66	0.23
TEKS Obj 2	91	0.34	0.26	0.63	0.26
TEKS Obj 5	92	0.53	0.24	0.72	0.28
TEKS Obj 6	92	0.51	0.27	0.65	0.26
Control Group					
TEKS Obj 1	45	0.48	0.24	0.65	0.23
TEKS Obj 2	46	0.39	0.22	0.67	0.22
TEKS Obj 5	47	0.44	0.27	0.75	0.23
TEKS Obj 6	47	0.57	0.29	0.70	0.25

Table 8

Correlations for TAKS Subscales

	TEKS Obj 1	TEKS Obj 2	TEKS Obj 5	TEKS Obj 6
TEKS Obj 1	1.00			
TEKS Obj 2	0.73***	1.00		
TEKS Obj 5	0.48***	0.37***	1.00	
TEKS Obj 6	0.73***	0.65***	0.39***	1.00

Note. $^{***}p \leq 0.001$

The MANCOVA investigated the group differences among the TAKS posttest subscale scores while controlling for the pretest TAKS subscale scores. The results yielded that there was no statistically significant difference between groups, Wilks' Lambda=0.984, $F(4, 125)=0.52$, $p=0.72$. However, students increased on all objectives.

Results: Students' Math Anxiety

Research Question Two: Will there be group differences between the experimental and control groups' math anxiety?

Hypothesis 2: It was hypothesized that students who received the OVITT would have decreased math anxiety compared to the students who did not receive the OVITT, as measured by the Math Anxiety Scale-Revised.

Math anxiety "is a feeling of tension and anxiety that interferes with the 'manipulation of mathematical' problems in varied situations" (Khatoon & Mahmood, 2010, p. 75). Sample sizes, means, and standard deviations are shown in Table 9 comparing the experimental and control groups for the Math Anxiety Scale-Revised Positive and Negative subscales.

Table 9

Means and Standard Deviations for MAS-R Scores

MAS-R Subscales	Pretests			Posttests	
	n	*M*	*SD*	*M*	*SD*
Experimental Group					
Positive	88	3.64	1.04	3.80	0.95
Negative	88	2.33	1.03	2.04	0.79
Control Group					
Positive	39	2.89	1.03	2.78	1.18
Negative	39	2.44	0.94	2.23	1.11

The MAS-R mean scores were represented by Positive and Negative subscale scores. Item numbers 1, 3, 5, 10, 12, and 13 are positively formed statements about math and item numbers 2, 4, 6, 7, 8, 9, 11, and 14 are negatively formed statements about math (Appendix E). Students responded on a 5-point Likert scale from “not true” (1), to “very true” (5). The experimental group’s Positive subscale mean scores slightly increased from pretest to posttest. The experimental group’s Negative subscale mean scores decreased from pretest to posttest. The control group slightly decreased from pretest to posttest on the mean scores for the Positive subscales. The control group’s mean scores for the negative subscales also slightly decreased from pretest to posttest.

A correlation matrix was conducted to check for possible correlations. The Positive subscale and Negative subscale correlated. Table 10 shows the correlation of subscales. Due to a correlation between the two subscales being present, a MANCOVA was conducted to determine if there was a statistically significant difference on the MAS-R Positive and Negative scores. The dependent variable was the posttest scores of the MAS-R and the pretest scores were the covariate for the MAS-R Positive subscale and Negative subscale separately. There was a statistically significant difference between the experimental and control groups MAS-R overall subscale scores, Wilks' Lambda= 0.914, $F(2, 122) = 5.71$, $p = 0.004$, partial eta squared = 0.086. With further examination, there was a statistically significant difference between the experimental and control groups MAS-R Positive subscale scores, $F(1, 124) = 11.44$, $p = 0.001$, partial eta squared = 0.085 as opposed to the MAS-R Negative subscale scores, $F(1,124) = 0.865$, $p = 0.354$, partial eta squared = 0.007. Therefore, the hypothesis was supported.

Table 10

Correlations for MAS-R Subscales

	MAS-R Positive	MAS-R Negative
MAS-R Positive	1.00	
MAS-R Negative	-0.36***	1.00

Note. ***p ≤ 0.001

Results: Students' Math Attitudes

Research Question Three: Will there be group differences between the experimental and control groups' attitudes toward math?

Hypothesis 3: It was hypothesized that students who received the OVITT would have more positive attitudes toward math compared to the students who did not receive the OVITT, as measured by the Attitudes Towards Math Inventory.

Math attitudes are the “general emotional disposition toward the school subject of mathematics” (Haladyna, Shaughnessy, & Shaughnessy, 1983, p. 20). The Attitudes Towards Math Inventory measured students’ math attitudes. An ANCOVA was conducted to determine if there was a statistically significant difference on the ATMI total scores between the experimental and control group. The posttest of the ATMI total scores was the dependent variable while the pretest ATMI performance total scores served as the covariate. The sample sizes, means, and standard deviations are shown in Table 11.

Table 11

Means and Standard Deviations for ATMI Total Scores

ATMI Total Scale	Pretests			Posttests	
	n	*M*	*SD*	*M*	*SD*
Experimental Group	73	15.24	2.51	13.84	1.71
Control Group	27	13.91	2.97	12.70	1.93

There was no statistically significant difference between the experimental and control group on their posttest scores, $F(1, 97) = 3.07$, $p = 0.083$. Although there were no significant differences, the experimental group began with higher overall math attitudes. However, there was an overall decrease of math attitude scores from pretest to posttest for both groups. There were four subscales of the ATMI, self-confidence, value, effort, and motivation. Table 12 provides the sample sizes, means, and standard deviations of the TAKS subscales for both groups.

Table 12

Means and Standard Deviations for ATMI Subscale Scores

ATMI Subscales		Pretests		Posttests	
	n	*M*	*SD*	*M*	*SD*
Experimental Group					
Self-Confidence	78	3.83	0.71	2.78	0.36
Value	81	4.06	0.59	4.08	0.62
Enjoyment	84	3.70	0.73	3.62	0.60
Motivation	84	3.66	0.90	3.37	0.72
Control Group					
Self-Confidence	30	3.51	0.87	2.85	0.40
Value	30	3.76	0.71	3.69	0.74
Enjoyment	28	3.22	0.84	3.19	0.67
Motivation	29	3.37	0.83	2.93	0.71

Students in the experimental group had higher scores from pretest to posttest on each of the ATMI subscales except they were slightly lower on the posttest of the Self-confidence subscale. On the other hand, both groups decreased in all areas except the experimental group had a slight increase on the Value subscale. The greatest decrease for both groups pertained to self-confidence and motivation.

A correlation matrix was conducted to check for possible correlations. Table 13 shows the correlation of subscales. Since the subscales correlated with one another, a

MANCOVA was conducted with the posttest of the individual objectives as the dependent variable and the pretest of each objective as the covariate. The MANCOVA investigated the group differences among the ATMI posttest subscale scores while controlling for the pretest ATMI subscale scores. The results yielded that there was no statistically significant difference between groups, Wilks' Lambda=0.97, $F(4, 91) = 0.71$, $p = 0.587$. Therefore, the hypothesis was not supported. However, there were differences within the groups on each of the subscales.

Table 13

Correlations for ATMI Subscales

	Self-Confidence	Value	Enjoyment	Motivation
Self-Confidence	1.00			
Value	0.56***	1.00		
Enjoyment	0.78***	0.75***	1.00	
Motivation	0.67***	0.69***	0.80***	1.00

Note. ***$p \leq 0.001$

Results: Students' Gender, Ethnicity, and Mothers' Education

Research Question Four: Will there be differences between experimental and control groups in math performance, math anxiety, and math attitudes compared by gender, ethnicity, and parents' education?

Hypothesis 4:

a) It was hypothesized that boys would score higher, white students would score higher, and students with more educated parents would score higher on the 2009 released 6^{th} Grade Math TAKS test.

b) It was hypothesized that there would be no significant group differences on the Math Anxiety Scale-Revised and Attitudes Towards Math Inventory when compared by ethnicity and parents' education.

c) It was hypothesized that girls would score higher on the Math Anxiety Scale-Revised and would score lower on the Attitudes Towards Math Inventory.

Genders of the student participants were male and female. The ethnicity variable originally had eight different categories. Due to low numbers, American Indian or Alaska Native, Asian, Biracial, Native Hawaiian or other Pacific Islander, and unspecified Other were combined to create a new category of "Other." In regards to the parents' education, the mothers' education was used as the grouping variable because there was more complete information available as opposed to the fathers' education. The mothers' levels of education were divided into two categories: those with a high school education or less and those with some college credit or college degree.

Comparisons of the students' math performance were measured with the TAKS percent pre- and post-tests, with students grouped by genders using a factorial ANCOVA. There were not significant differences between experimental and control groups or between genders, nor was there a significant interaction effect. As hypothesized, the boys scored slightly higher, but only in the control group. However, girls in the experimental group scored higher than the boys. The posttest means and standard deviations are displayed in Table 14.

Table 14

TAKS Total Percent Posttest Scores by Gender

	Male			Female		
	n	*M*	*SD*	*n*	*M*	*SD*
Experimental	38	0.63	0.24	52	0.69	0.21
Control	20	0.70	0.20	24	0.67	0.21

When grouped by ethnicity, the students' TAKS percent scores were compared using a factorial ANCOVA. There were no significant differences. The means and standard deviations for the posttest scores are displayed in Table 15. Contrary to the hypothesis, White students did not score significantly higher. The results should be interpreted with caution due to the small numbers in each ethnic group, especially in the control group classroom.

Table 15

TAKS Total Percent Posttest Scores by Ethnicity

	Hispanic			Black			White			Others		
	n	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Experimental	36	0.65	0.23	12	0.60	0.24	29	0.68	0.24	13	0.73	0.17
Control	19	0.70	0.17	5	0.41	0.18	13	0.73	0.22	7	0.77	0.15

A factorial ANCOVA test compared the TAKS percent scores for students in the experimental and control classrooms, grouped by levels of the mothers' education. It was hypothesized that students would demonstrate higher math achievement if their parents' educations levels were higher. The results were non-significant. However, students with college educated mothers in the experimental group scored slightly higher on the posttests (Table 16).

Table 16

TAKS Total Percent Posttest Scores by Mothers' Education

		High School or Less		College Credit or College Degree	
	n	*M*	*SD*	*M*	*SD*
Experimental	44	0.63	0.23	0.73	0.21
Control	27	0.71	0.17	0.67	0.26

Students in the experimental and control groups were compared based on ethnicity and mothers' education on the Attitudes Towards Math Inventory and also compared by ethnicity and mothers' education on the Math Anxiety Scale Revised. It was hypothesized that there would not be significant group differences. The comparisons of the students' math attitudes were measured with the Attitudes Towards Math Inventory pre- and post-tests, with students grouped by ethnicity using a factorial ANCOVA. There were no significant differences between the experimental and control groups or among the ethnicity groups. All ethnicity groups decreased from pretest to posttest in the experimental and control group pertaining to students' self-confidence. Hispanics were the only ethnicity group to have a slight increase from pretest to posttest pertaining to students' value. However, all ethnicity groups in the control group increased on value except White students with a slight decrease. White and Other students in the experimental group and Black and Other students in the control group increased on the Enjoyment subscale. All ethnicity groups within the experimental and control groups decreased from pretest to posttest on the Motivation subscale (Table 17).

Table 17

Pretest and Posttest of ATMI Subscale Scores by Ethnicity

	Experimental					Control				
		Pretest		Posttest			Pretest		Posttest	
	n	*M*	*SD*	*M*	*SD*	*n*	*M*	*SD*	*M*	*SD*
Hispanic	30					9				
Self-Confidence		3.76	0.67	2.82	0.41		3.89	0.43	2.66	0.27
Value		4.06	0.50	4.21	0.48		3.62	0.47	3.61	0.71
Enjoyment		3.80	0.68	3.68	0.47		3.40	0.43	3.37	0.65
Motivation		3.67	0.74	3.44	0.61		3.22	0.60	2.88	0.76
Black	13					5				
Self-Confidence		3.87	0.74	2.87	0.35		3.27	0.70	3.13	0.48
Value		4.10	0.83	3.94	0.85		4.06	0.64	4.00	0.82
Enjoyment		3.79	0.83	3.55	0.88		3.22	0.91	3.30	0.59
Motivation		3.86	1.07	3.48	0.76		3.64	0.38	3.24	0.55
White	19					8				
Self-Confidence		3.75	0.80	2.84	0.35		3.40	0.83	2.82	0.40
Value		3.98	0.60	3.89	0.67		4.00	0.34	3.68	0.42
Enjoyment		3.42	0.67	3.51	0.51		3.20	0.94	3.05	0.75
Motivation		3.50	0.77	3.22	0.71		3.68	0.75	2.88	0.61
Others	11					5				
Self-Confidence		4.08	0.62	2.63	0.25		3.12	1.64	3.07	0.54
Value		4.18	0.49	4.15	0.57		3.52	1.49	3.52	1.29
Enjoyment		3.66	0.88	3.67	0.73		2.90	1.35	3.02	0.85
Motivation		3.78	0.99	3.25	0.86		3.12	1.50	2.88	1.11

The experimental and control groups were also compared by mother's education on the ATMI using a factorial ANCOVA. There were no significant group differences. Students in both groups whose mothers were college educated and those who were not decreased on all four subscales of the ATMI except for students in the experimental group whose mothers who had less than college level slightly increased on the value subscale (Table 18).

Table 18

Pretest and Posttest of ATMI Subscale Scores by Mothers' Education

	Experimental					Control				
		Pretest		Posttest			Pretest		Posttest	
	n	*M*	*SD*	*M*	*SD*	*n*	*M*	*SD*	*M*	*SD*
High school or less	37					16				
Self-Confidence		3.68	0.68	2.81	0.32		3.45	0.70	2.83	0.33
Value		3.91	0.62	4.01	0.66		3.71	0.45	3.54	0.56
Enjoyment		3.60	0.77	3.59	0.58		3.06	0.72	3.02	0.73
Motivation		3.49	0.83	3.35	0.67		3.31	0.66	2.74	0.64
College credit or degree	30					10				
Self-Confidence		4.03	0.72	2.74	0.33		3.49	1.24	2.90	0.57
Value		4.27	0.49	4.18	0.56		4.02	1.05	4.00	0.98
Enjoyment		3.81	0.68	3.65	0.61		3.44	1.07	3.49	0.57
Motivation		3.93	0.77	3.37	0.73		3.64	1.08	3.34	0.77

Comparisons of the students' math anxiety were measured with the MAS-R. The students in the experimental group increased on the Positive subscale for all ethnic groups except Black students. All ethnic groups except for Hispanics increased in control group on the Positive subscale. In addition, all ethnic groups in the experimental group decreased on the Negative subscale (Table 19).

Table 19

Pretest and Posttest of MAS-R Scores by Ethnicity

	Experimental					Control				
		Pretest		Posttest			Pretest		Posttest	
	n	*M*	*SD*	*M*	*SD*	*n*	*M*	*SD*	*M*	*SD*
Hispanic	35					20				
Positive		3.94	0.81	4.03	0.79		3.00	1.00	2.68	1.10
Negative		2.44	1.04	2.14	0.91		2.36	0.79	2.16	0.95
Black	12					6				
Positive		3.82	1.28	3.72	1.18		3.08	1.12	3.22	1.52
Negative		2.40	0.87	2.11	0.67		2.65	0.76	2.35	1.49
White	27					6				
Positive		3.17	1.15	3.56	1.04		2.83	0.82	2.97	1.18
Negative		2.31	1.23	2.00	0.77		2.60	1.40	2.27	1.33
Others	14					7				
Positive		3.64	0.89	3.76	0.89		2.48	1.33	2.57	1.33
Negative		2.04	0.77	1.81	0.61		2.39	1.23	2.29	1.30

A factorial ANCOVA was also used to examine if there were any significant differences between groups based on the MAS-R based on the students' mothers' education. Students in both groups whose mothers were college educated and those who were not increased on the Positive subscale except students' mothers with a high school degree or less in the control group. All groups decreased on the Negative subscale (Table 20).

Table 20

Pretest and Posttest of MAS-R Scores by Mothers' Education

	Experimental					Control				
		Pretest		Posttest			Pretest		Posttest	
	n	*M*	*SD*	*M*	*SD*	*n*	*M*	*SD*	*M*	*SD*
High school or less	44					26				
Positive		3.66	1.05	3.71	1.02		2.82	0.96	2.66	1.09
Negative		2.57	1.07	2.18	0.90		2.24	0.80	2.20	0.99
College credit or degree	37					10				
Positive		3.62	1.09	4.01	0.81		3.02	1.27	3.17	1.54
Negative		2.00	0.96	1.85	0.66		2.88	1.27	2.38	1.57

Comparisons of the students' math anxiety were measured with the Math Anxiety Scale-Revised pre- and post-tests, with students grouped by gender using a factorial ANCOVA. There were no significant differences between experimental and control groups or between genders, nor was there a significant interaction effect. Males and females in the experimental group increased on the Positive subscale. Males and females in both groups decreased in the Negative subscale of math anxiety (Table 21).

Table 21

Pretest and Posttest of MAS-R Scores by Gender

	Experimental					Control				
		Pretest		Posttest			Pretest		Posttest	
	n	*M*	*SD*	*M*	*SD*	*n*	*M*	*SD*	*M*	*SD*
Male	37					18				
Positive		3.41	1.13	3.77	0.93		2.93	1.04	2.87	1.20
Negative		2.44	1.07	2.16	0.84		2.21	0.87	1.82	0.73
Female	51					21				
Positive		3.81	0.95	3.83	0.97		2.87	1.06	2.71	1.19
Negative		2.26	1.02	1.95	0.75		2.65	0.98	2.58	1.28

A factorial ANCOVA test compared the experimental and control groups' math attitudes. Comparisons of the students' math attitudes were measured with the Attitudes Towards Math Inventory, with students grouped by genders. There were not significant differences between experimental and control groups or between genders, nor was there a significant interaction effect. However, there was a decrease for males and females in both groups on the Self-confidence and Motivation subscale from pretest to posttest. Females in the experimental group had a slight increase in the Value subscale. Males in both groups had a slight increase in the Enjoyment subscale (Table 22).

Table 22

Pretest and Posttest of ATMI Subscale Scores by Gender

	Experimental					Control				
		Pretest		Posttest			Pretest		Posttest	
	n	*M*	*SD*	*M*	*SD*	*n*	*M*	*SD*	*M*	*SD*
Male	31					16				
Self-Confidence		3.83	0.77	2.80	0.33		3.61	1.04	2.90	0.48
Value		4.04	0.56	3.97	0.57		3.79	0.83	3.64	0.85
Enjoyment		3.59	0.85	3.60	0.63		3.16	1.01	3.21	0.76
Motivation		3.63	0.84	3.39	0.75		3.39	1.00	2.96	0.85
Female	42					11				
Self-Confidence		3.82	0.67	2.80	0.39		3.30	0.68	2.83	0.44
Value		4.09	0.61	4.14	0.65		3.80	0.63	3.75	0.66
Enjoyment		3.75	0.65	3.62	0.59		3.30	0.59	3.18	0.60
Motivation		3.72	0.85	3.34	0.66		3.45	0.54	2.93	0.56

Results: Brainingcamp Questionnaire

Students in the experimental group answered a questionnaire regarding their experience with using Brainingcamp. There were nine total questions, with the first eight pertaining to the navigational use, understanding of topics taught, interaction, helpful hints, providing repetition of information, progress, computer use, and whether or not Brainingcamp was motivational to their learning. Students were to state whether or not they agreed with those areas. The ninth question was open-ended for the students to explain their experience with Brainingcamp in their own words (Appendix H). The responses were read and tallied based on the different types of responses students stated and then organized by the 15 different types of responses provided in Table 24. The frequencies and percentages are provided in Table 23 and Table 24 of the students' responses of the first eight questions and of the students' responses to question #9 respectively.

Table 23

Frequencies and Percentages of Brainingcamp Questionnaire

	Agree		Disagree	
Items	*f*	%	*f*	%
Q1 Brainingcamp navigation	73	83.9	14	16.1
Q2 Brainingcamp easy to understand	73	83.9	14	16.1
Q3 Brainingcamp interactive	74	85.1	13	14.9
Q4 Brainingcamp helpful hints	53	61.6	33	38.4
Q5 Brainingcamp repeat	83	98.8	1	1.2
Q6 Brainingcamp see progress	78	92.9	6	7.1
Q7 Brainingcamp computer use was confusing	11	13.3	71	85.5
Q8 Brainingcamp motivate learning	66	81.5	14	17.3

There were a high percentage of students in the experimental group that agreed with the statements posed in the questionnaire regarding Brainingcamp. A majority of the students believed Brainingcamp provided them repetition and the opportunity to see their progress with 98.8% and 92.9% of the students who agreed respectively. In addition, a majority of the students believed Brainingcamp was not confusing to use because 85.5% disagreed that it was confusing.

Table 24

Frequencies and Percentages of Brainingcamp Questionnaire #9

Students' Responses	*f*	%
Helpful to go over mistake	8	10.0
Learning topics are better	8	10.0
Helpful-interactive	6	7.5
Helpful taught in different ways	2	2.5
Helpful to understand process and examples	26	32.5
Helpful-easy to understand/fun	5	6.3
Learned at own pace	6	7.5
Resources are available	1	1.3
Not making sense	1	1.3
Not well explained	4	5.0
Helpful on some topics, prefer teacher	4	5.0
Interactive games	2	2.5
Provides opportunity for practice	4	5.0
Gave suggestions	2	2.5
Not helpful, already knew information	1	1.3
Total	80	100.0

The last question, #9, on the questionnaire students provided an open-ended response about their experience with Brainingcamp. Majority of the students stated that they had a positive experience. Many of the students who believed it to be helpful stated the reason was that Brainingcamp provided examples that were helpful to them in understanding the math topic within the lesson and activities the students completed (32.5%).

Summary

The purpose of the study is to investigate whether the use of an online and interactive technological tool could be utilized in the 6th grade classroom to increase students' math performance in conjunction with reducing students' math anxiety and increasing their positive attitudes/perceptions of math. The researcher determined that the hypotheses were not supported because there were no statistical significant differences.

The outcomes of this study did not support the hypotheses of math performance and attitudes towards math affirming that there was no statistical significant difference in the posttest scores between the experimental and the control groups when using the pretest scores as a covariate. However, a MANCOVA showed that there was a statistically significant difference between the experimental and control groups' Positive and Negative math anxiety scores. With further examination, the significant difference pertained to the MAS-R Positive subscale scores. In addition, there was no significant difference between the experimental and control groups based on gender, ethnicity, and mothers' education. Overall, students showed differences within the experimental and control group in that all students improved from pretest to posttest.

CHAPTER V

DISCUSSION

Introduction

Students' math performance is an important area of learning and mastery so that students can have the opportunity to pursue future careers in science, technology, engineering, and mathematics (Nugent et al., 2010). Few studies have investigated online, visual technological programs effect on middle school students, specifically 6th grade students' achievement in math. In order to help all students become better critical thinkers and apply their math skills in daily life successfully, it is important for students to receive tools and strategies that can develop and enhance those skills. This research sought to provide information to help increase 6th grade students' math performance. In addition, the research study investigated a method in reducing students' math anxiety and increasing their positive attitudes/perceptions of math. This chapter will address the following: summary of the study, discussion of the findings, the implications in regards to the relevant literature, study limitations, recommendations for future research, and the conclusion.

Summary of Study

The purpose of this study was to aid in closing the gaps in this area of research by investigating whether the use of an online and interactive technological tool could be utilized in the 6th grade classroom to increase students' math performance in conjunction with reducing students' math anxiety and increasing their positive attitudes of math. Bandura's Theory of Self-efficacy, Piaget's theory of Cognitive Development, and Vygotsky's Learning Theory were used as the theoretical frameworks for this study.

The data collected was from 155 parents and their 6th grade students from a middle school in the North Texas area. The parents' and students' information was collected through the Demographic Information Form. The students' information on math performance, math anxiety, and math attitudes were gathered using the 2009 TAKS test, MAS-R, and ATMI survey respectively. Information regarding the use of Brainingcamp was gathered from students in the experimental group. The research findings are described in the following section.

Discussion of Findings

Research Question One

Will there be group differences between the experimental and control groups' math performance based on the use of an online visual and interactive technological learning tool?

Hypothesis 1: It was hypothesized that there would be statistically significant differences in the math performance scores between the students that received the OVITT designed to provide students' rigorous learning through interaction and engagement for the time frame of three months and the students who did not receive the OVITT, as measured by the 2009 released 6th Grade Math TAKS test.

The National Center for Education Statistics (2009) defined math performance as a student's ability to display proficiency of math through the application of the content in various situations, such as analytically and in the real world. Educators are to ensure that students perform at a high level and provide the necessary methods and tools to aid in students' success in math (NCTM, 2012). The integration of technology is one of the tools used to aid in an increase in students' math performance (NCTM, 2012). The experimental group received the Brainingcamp intervention, an online visual interactive technological tool. The students in the experimental and control groups completed the 2009 Texas Assessment of Knowledge and Skills (TAKS) test as the pretest and posttest to measure their math performance. This instrument consisted of 33 items grouped with the following four subscales: Objective 1 is Numbers, Operations, and Quantitative Reasoning, Objective 2 is Patterns, Relationships, and Algebraic Thinking, Objective 5 is Probability and Statistics, and Objective 6 is Underlying Processes and Mathematical Tools (problem solving).

An ANCOVA was used to control for any group differences using the pretest as the covariate. There were no significant differences between the experimental and control groups, but there were improvements of the total percent scores on the TAKS from pretest to posttest within both groups. The control group had slightly higher overall scores; however, their TAKS scores were higher from the beginning. Although the math performance results were not statistically significant between groups, students' scores on their math performance in both groups increased by about 20% from pretest to posttest in a three month period. Findings by Hiebert et al. (2005) have shown that teaching in the U.S. tended to be unchallenging and mostly consisted of procedural math tasks. However, in this study, there was a substantial increase on the math performance from pretest to posttest in the three month time span for the experimental and control groups. Students were taught using methods that consisted of higher level thinking and application as opposed to just rote memorization of math facts.

The four subscales were examined after a correlation matrix was conducted to check for possible correlations. Since there were correlations present, a MANCOVA was conducted with the posttests of the individual objectives as the dependent variables and the pretests of each objective as the covariates. The results were not significant between groups, however, students improved within each subscale by 10-30%. The control group did slightly better on all objectives except for Objective 1. The greatest improvement for the experimental group was on Objective 2 with a 29% increase. On the other hand, the control group had a 31% increase on Objective 5. Fractions and fraction operations are one of the specific topic areas in math that students struggle with on computation. Students must have a strong rational number sense in order to help them in working with fractions (Mazzocco & Devlin, 2008). Objective 1 in the study pertained to rational numbers. Students in both groups improved from pretest to posttest by up to 21%. Although the improvement in this area was not as high as Objective 2 and 5, students did better on Objective 1 than Objective 6 in both groups. Schneider, et al. (2009) discussed students' ability to reason and think critically in solving complex problems in math is correlated with their numerical intelligence. According to Piaget's Theory of Cognitive Development (1968), 6^{th} grade students are transitioning from Concrete Operations to Formal Operations. They are beginning to enter into higher level thinking and reasoning in order to transfer concrete knowledge abstractly. Problem solving is a difficult area for students in math. This was evident due to Objective 6 being the lowest area of improvement within the experimental and control groups in the current study. Piaget (1972) stated that children should be using logical reasoning in their learning. Therefore, further research is needed to understand the way students acquire and process information because according to Piaget (1968) a child's schema includes a combination of their experiences, beliefs, perceptions, and information that affect learning.

Mazzocco and Devlin (2008) recommended future investigation of instructional methods used in the classroom to help students grasp math concepts. There has been investigation of the use of teaching methods in other countries compared to the United States, but the results were not significant. However, in this study, due to students' diverse learning styles, it was essential to teach using multiple methods to support the various ways students learn. Conceptual teaching strategies provide students the ability to be active thinkers and problem solvers (Smith et al., 2005). This style of teaching is supported due to the high math results of students in other countries. The teachers in this study planned lessons together to help students improve their critical thinking skills and learn the basic math skills in order to apply them in multiple mathematical situations. A possible reason for the increase in students' TAKS subscales and overall could be due to the teaching strategies used. This possible reason could be due to the way the teachers taught the math content. Schneider et al. (2009) findings show that when there is a successful connection with students' conceptual and concrete understanding, students' can transfer their knowledge and build new knowledge consistently. This was seen from pretest to posttest for both groups within all the TAKS objectives.

Research Question Two

Will there be group differences between the experimental and control groups' math anxiety?

Hypothesis 2: It was hypothesized that students who received the OVITT would have decreased math anxiety compared to the students who did not receive the OVITT, as measured by the Math Anxiety Scale-Revised.

According to Khatoon and Mahmood (2010), math anxiety pertains to mathematical situations, such as problem solving, that cause a person to become tense and anxious when working in those mathematical situations. Math anxiety was first assessed by Richardson and Suinn in 1972 using the Math Anxiety Scale Rating (Ashcraft, 2002). In this study, the Math Anxiety Scale Revised, MAS-R, was used to assess students' math anxiety. It contained 14-items where students had to rate each question on a 5-piont Likert scale from "not true" to "very true". The MAS-R mean scores were represented by Positive and Negative subscale scores. The experimental and control groups showed a decrease in their Negative subscale scores from pretest to posttest, however, the experimental group increased on their Positive subscale scores.

A correlation matrix was conducted to check for possible correlations in which there were between both subscales. Therefore, a MANCOVA was used to determine if there was a significant difference between the groups. There was a significant difference on the MAS-R between the experimental and control groups. However, further examination showed that there were no significant differences between experimental and control groups on the Negative subscale score, but there was with on the Positive subscale score. One should be aware in making inferences regarding the experimental and control groups because the effect sizes were small.

Overall, students in both groups began with higher levels of math anxiety (Negative subscale). Math anxiety affects students' math performance. This is supported by Ma's (1999) findings that students' math anxiety occurs within the elementary years and continues into high school and beyond based on different reasons. However, a notable reason for math anxiety is the transition from elementary to middle school because the math is different and at a higher level (Newstead, 1998). Math anxiety is known to have an emotional element involved where the student has fears and anxiety in mathematical situations. In this study, although students started with higher levels of math anxiety, it decreased from pretest to posttest. In addition, the experimental group increased on the Positive subscale. Putwain (2007) suggested that the reduction of stress is the best way to help children cope with their anxiety. It is possible that the use of an online visual and interactive technological tool was a way of reducing students' math anxiety in the experimental group since they had a slightly increased positive belief in their ability to perform well in math.

Research Question Three

Will there be group differences between the experimental and control groups' attitudes toward math?

Hypothesis 3: It was hypothesized that students who received the OVITT would have more positive attitudes toward math compared to the students who did not receive the OVITT, as measured by the Attitudes Towards Math Inventory.

Researchers have suggested examining students' beliefs, attitudes, and perceptions about math and how it can help to provide understanding in helping students' math performance (Graham, Taylor, & Hudley 1998). According to Haladyna, Shaughnessy, & Shaughnessy (1983), math attitudes pertain to the general view or stance a person has toward math. The Attitudes Towards Math Inventory, ATMI was used to measure students' math attitudes. It is a 40-item inventory that contained four subscales: Self-confidence, Value, Enjoyment, and Motivation. An ANCOVA was used to analyze the data and revealed that there were no significant differences between the experimental and control groups. Therefore, a MANCOVA was used due to a correlation being present among the four subscales. The results were also not significantly different.

Students in both groups decreased on their ATMI total scores. In addition, there was a decrease on each of the subscales from pretest to posttest for both groups, except the experimental group had a slight increase on the Value subscale. The experimental and control groups had their biggest decrease on the Self-confidence and Motivation subscales. These results align with Bandura's Self-Efficacy Theory. Students' beliefs of their ability affect their performance (Bandura, 1997). If students have a low self-confidence, they will be unmotivated to do well. The findings in the study suggest that it is possible that students' self-confidence and motivation started high due to being optimistic in the new math classroom and decreased as they learned the new math information and experienced 6^{th} grade math.

Middle school math is more difficult than elementary math due to having more information to learn because each year of schooling has an increased level of learning. Bandura (1997) stated that a student must have a strong sense of self-efficacy in order to handle the challenging problems and situations in the classroom and life. The findings of this study was not supported by some the research regarding student motivation because Ogbuehi and Fraser (2007) indicated students perception and attitudes were more positive toward math when students used engaging and creative learning methods. Therefore, it is possible as time continued, the math tasks became more difficult and students' motivation decreased because they felt incompetent in the 6^{th} grade math content.

Research Question Four

Will there be differences between experimental and control groups in math performance, math anxiety, and math attitudes compared by gender, ethnicity, and parents' education?

Hypothesis 4a:

It was hypothesized that boys would score higher, white students would score higher, and students with more educated parents would score higher on the 2009 released 6th Grade Math TAKS test.

The 2009 TAKS test was used to measure performance and was examined based on gender, ethnicity, and parents' education. The total percent scores of the TAKS were used with the two genders were male and female. There were no significant differences between the experimental group and control group. There were also no significant differences between male and female students. Male students did slightly better in the control group and female students did slightly better in the experimental group. This finding is somewhat similar to those of Else-Quest et al. (2010), who found a small variance where males ages 14-16 performed better than the females when we look at the control group in the current study. Although boys tend to outperform girls at this age, the females in the experimental group did better on their math performance. It could be possible that the gender of the teacher was a factor on the female students' math performance.

When analyzing the TAKS test based on ethnicity, it was hypothesized that White students would do better. Based on various studies, white students tend to do better than their counterparts (Haycock, 2001; Ladson-Billings, 1997; Lee, 2002: Martin, 2006). The findings of Shores, Smith, & Jarrell (2009) study that examined math achievement based on SES, gender and ethnicity, found there were no significant differences with ethnicity.

However, students that comprised the “Others” ethnicity group scored higher in the experimental and control group than the other ethnic groups. In the control group, follow-up tests indicated that African American students had significantly lower scores on their posttest (41%) compared to the other groups who were between 60-77%. Nonetheless, the group sizes were small. It could be explored more with larger group samples to see if the same results occur.

It was hypothesized that students’ whose parents had a higher education would do better on the TAKS test. The mothers’ education was used due to the information being more complete. Usually the socioeconomic (SES) status is represented by the household income or students having free or reduced lunch. Shores, Smith, & Jarrell (2009) suggested looking at the lived contexts of students which include the education of the parents or guardians they live with. Roksa and Potter (2011) have found that mothers’ educational levels, expectations, and experiences they provide their children affects the children’s educational achievement. Children in higher classes, such as the stable middle class, achieved at higher levels than other social classes. The findings align with the experimental group in the current study because students with college educated mothers scored higher on the posttest. This information was not true for the control group, but the difference between the two groups of mothers in the control group was a 4% difference.

Hypothesis 4b:

It was hypothesized that there would be no significant group differences on the Math Anxiety Scale-Revised and Attitudes Towards Math Inventory when compared by ethnicity and parents' education.

The ATMI and MAS-R were examined based on students' ethnicity and mothers' education in the experimental and control group. When compared, there were no statistically significant differences between the experimental and control group. The math attitudes of students were not significantly different among the various ethnic groups. The Motivation subscale was the only area within the ATMI that all ethnicity groups in the experimental and control groups decreased from pretest to posttest. This difference could be due to students' self-efficacy because if students believe math is hard, then their motivation to do well in math could decrease when presented with solving challenging math problems (Bandura, 1977).

Although the motivation of students decreased, there were students who increased in their value and enjoyment of math. Usually students identify with their teacher when they feel like they have shared experiences such as ethnic background. However, the White and Other students in the experimental group increased on the Enjoyment scale while the Black and Other students slightly increased on the same scale in the control group. This was interesting because the experimental groups' math teacher is an African American female and the control groups' math teacher is a White male. It is possible that students from all ethnic backgrounds have some shared attitudes about math.

A factorial ANCOVA was used to compare both groups by mother's education on the ATMI. The results were not significant between groups. All groups decreased on the subscales of the ATMI except students in the experimental group whose mothers who had less than a college level education. The findings show that it is possible no matter the educational level of the parent, that the students' personal feelings and beliefs of math still affects the students greatly.

A factorial ANCOVA was also used to compare the experimental and control groups by ethnicity and mother's education separately on the MAS-R. The results of the factorial ANCOVA on the MAS-R by ethnicity showed no significant differences. All students decreased on the Negative subscale, but in the experimental group the Black students were the only students who did not increase on the Positive subscale scores. This was also true for Hispanic students in the control group. This could be due to the students' perceptions about math. Future research should investigate math anxiety with ethnicity of the students to determine what makes students positive feelings decrease or negative feelings increase regarding math. In addition, researchers can examine possible aspects of math that cause students to become anxious.

The results of the MAS-R by mothers' education also were not significantly different as hypothesized. The educational level of the mothers was not statistically significant in relation to students' math anxiety. The educational background of parents is known to be influential to their child's schooling (Lee & Bowen, 2006). It has also been suggested that the socioeconomic background of the families is an influence on students' success in the classroom and a cause for anxiety. However, looking at the descriptive analysis, no matter the educational level of the mothers, students decreased on the Negative subscale. It is possible that students' math anxiety can decrease and the mothers' education may not have a strong impact on that change. The direct relation of those factors causing students math anxiety is a debatable area of concern (Newstead, 1998). However, parental involvement is a suggested method that could help to reduce students' anxiety in math (Martin, 2006).

Hypothesis 4c:

It was hypothesized that girls would score higher on the Math Anxiety Scale-Revised and would score lower on the Attitudes Towards Math Inventory.

Female students tend to have more math anxiety and negative attitudes towards math (Ho et al., 2000; Krinzinger, Kaufmann, & Willmes, 2009). This hypothesis was tested by analyzing the MAS-R and ATMI separately by gender. There were no significant differences between experimental and control groups or between genders, nor was there a significant interaction effect. On the MAS-R, males in the control group were the only students who did not increase on the Positive subscale. This is not supported by research because Collis (1987) examined 8th grade and 12th grade students' perceptions in math and hypothesized that female students would have more negative attitudes. The results showed that female students more often expressed negative views of math than male students. Else-Quest et al. (2010) also found that male students had more positive attitudes than female students. In addition, this study revealed all groups decreased in the

Negative subscale of math anxiety no matter their gender. Overall, the results reveal that students decreased on their negative views or feelings of anxiety towards math throughout their learning process.

A critical component in understanding students math performance is the affect their attitudes of math. There have been studies that examined students' math attitudes and perceptions and have suggested that gender differences are important (Else-Quest et al., 2010; Middleton & Spanias, 1999). Most studies have examined individual aspects of students' attitudes. Motivational factors have been found to be a trend for girls in relation to their mathematics achievement because they desire to connect with their math teacher more than boys (Middleton & Spanias, 1999). In addition, Else-Quest et al. (2010) found that gender differences in math achievement correlated with students' self-confidence.

Means and standard deviations were provided for the ATMI by gender. There were no statistically significant differences. The results of the study showed a decrease for all students in the Self-confidence and Motivation subscales. Overall, male students enjoyed math throughout their learning. Female students in the experimental group were the only ones who improved on their value of math from pretest to posttest. A possible reason for the increase of the Value subscale could be based on the teacher's belief in teaching expressed to the students in the way she teaches math, this could also be true for the boys increased enjoyment for the teaching styles their respective teachers use. Furthermore, a possible reason for the decrease in students' Self-confidence and

Motivation could be based on the math concepts learned throughout the process being difficult for the students.

Brainingcamp Questionnaire

Students need to be able to communicate, collaborate, and have guidance in their learning of mathematics in order to improve their present level of ability to reach their potential. The use of an online visual interactive technological tool provides students that opportunity. Scaffolding not only comes from human beings, but can be provided from technology. According on the Zone of Proximal Development from Vygotsky's Learning Theory (1978), the goal is for children to reach their potential through assistance from a more knowledgeable peer or adult through scaffolding. Therefore, technological tools can also be used to improve children's ability.

The Brainingcamp Questionnaire was given to the experimental group to gather information on their experience with the program. There were a total of nine questions, eight of them were statements that the students were to either agree or disagree with while the last question required an open-ended response. Of the eight questions posed, a majority of the students felt that they were able to repeat problems that they did not do well on and the opportunity to see their progress on the different topics they completed. These findings are similar to Koedinger, McLaughlin, & Heffernan (2010) who found that the ASSISTment computer program was helpful to students because it providing scaffolding to aid in students' proficiency in math. Students were provided opportunities for hints and to redo the problem they missed. This also helped students to know their progress. However, the study differed from this current study because the experimental group did better than the control group overall from pretest to posttest. Although both groups increased in this study, despite having an intervention, more time with the program could have provided more of a difference between the groups.

Students had open-ended responses to Question #9 which asked them to discuss their experience with Brainingcamp, if they believed it to be helpful to their learning, and to support it with the reason for their belief. There were 87.6% of the students that mentioned something positive about Brainingcamp either being helpful to some level, interactive, resourceful, provided suggestions, or allowed the students to go at their own pace in solving the math problems presented. Majority of the students believed Brainingcamp helped them understand the process and provided examples.

Previous studies have found that students who received the computer assisted instruction showed higher overall math achievement (Rivet, 2001). These findings were similar to Zhang (2005) who examined the computer technology as a solitary instructional method compared to traditional teachings. The results were not statistically different between groups, but both groups improved. However, in this current study, the students in the experimental and control group were still taught by the teacher who used similar teaching strategies to adhere to the various learning styles. There were students who felt that Brainingcamp was not making sense to them or did not explain the problems well. In addition, there was a very small percentage that believed it was not helpful because they knew the information being taught or believed Brainingcamp was helpful, but preferred the teacher instead. Overall, computer programs provide children a way to interact with their environment and learning in a different way (Woolfolk & Perry, 2012). Since there are differences on the level of influence of computer-assisted instruction on math achievement, future research should continue to explore the probable influence of computer use in the classrooms with math.

Conclusions

The purpose of this current study was to investigate whether the use of an online and interactive technological tool could be utilized in the 6th grade classroom to increase students' math performance in conjunction with reducing students' math anxiety and increasing their positive attitudes/perceptions of math. The findings in a study by Hoy, Tarter, and Hoy (2006) indicated that there is a collective aspect in understanding students' mathematical performance. This study used the 2009 TAKS test to measure 6th grade students' math performance, the Math Anxiety Scale Revised to measure their math anxiety, and the Attitudes Towards Math Inventory to measure their math attitudes. In addition, the Brainingcamp Questionnaire was created to gather information on experimental group's experiences with Brainingcamp at the middle school in the North Texas area. It is important to recognize that based on the results in the study, students made gains on their math performance in the experimental and control groups from pretest to posttest in a short amount of time. The academic performance of students is a continuous concern especially pertaining to mathematics. When students are able to take the information they learn and apply it effectively to show improvement, then students are able to extend their knowledge and application of mathematics in multiple ways. The investigations were also key because based on the literature review, there is limited information regarding online, visual technological programs effect on middle school students, specifically 6^{th} grade students' achievement in math. The findings of this study led to the following conclusions:

1. The analyses of this study revealed that students in the experimental and control groups improved on their math performance from pretest.
2. This study found that students' math anxiety decreased on their negative feelings of anxiety about math.
3. The results of the study showed that overall students in both groups decreased from pretest to posttest on their attitudes toward math. The greatest decrease was on the Self-confidence and Motivation subscales.
4. The results of the study showed that boys scored higher in the control group and girls scored higher in the experimental group on the 2009 TAKS test.
5. Based on ethnicity on the TAKS test, the results showed the Others ethnicity group had higher scores in both groups. African American students had the lowest total percent score in the control group.
6. This study found that students with college educated mothers in the experimental group scored higher on their math performance.

7. This study found all ethnicities in both groups decreased on their self-confidence and motivation on math attitudes.
8. The results of the study showed that overall, no matter the educational level of the students' mothers, there was an overall decrease on the self-confidence, value, enjoyment, and value of math except for students in the experimental group whose mothers who had less than college level slightly increased on the value subscale.
9. The results show that all students decreased on the Negative subscale based on ethnicity. However, in the experimental group, the Black students were the only students who did not increase on the Positive subscale scores and Hispanic students within the control group.
10. The results show that students' math anxiety was not affected by the mother's educational level. Students in both groups decreased on the Negative subscale.
11. The analyses of this study revealed males in the control group were the only students who did not increase on the Positive subscale of math anxiety and both genders of students decreased on their negative views or feelings of math anxiety.
12. The analyses of this study revealed that males in the control group increased on their enjoyment of math and female students in the experimental group increased on their value of math.

Limitations

Although this study had some notable strengths, there were limitations that were present. The participants in this study were from one grade level at one middle school the North Texas area where one of the teachers was the researcher in the study. In addition, a larger sample size could have made it possible for significant differences to be identified between the experimental and control groups. With a small sample size, the generalizability of the findings was limited. A small number of parents provided consent for the control group. Additionally, there were students who did not answer every question on the instruments in the study. This could have been a mistake, maybe some of the students skipped a question and forgot to return back to answer it.

Another limitation for this study was the length of time. This study was conducted in a three month time span. Although students in both groups increased on their math performance, there could have been more information present and different results could have occurred on the other measures if more time was included. Future research should include extended time and more participants.

Implications

Although there are limitations present in the current study, there were several implications revealed for parents, teacher educators, and school administrators. This research study was conducted to provide a way to close the gaps in research regarding online visual interactive technological tools and math performance of students in 6th grade. It also examined math anxiety and math attitudes of 6th grade students. Students' success in math is a collective effort from parents, teachers, school administrators and students. If students are to become better consumers of the knowledge gained in the classroom and become the needed future leaders in the fields of science, technology, engineering, and mathematics, it is vital to know what the adults in their life are doing to foster knowledge.

The level of parental support and involvement may provide their children higher levels of motivation which would also build their self-confidence that would help in their math learning. When students feel encouragement from all areas in their life, it could provide the extra push students need to have a better attitude towards life situations, such as learning math. Furthermore, according to Bandura, the self-efficacy of a person effects the motivation to perform well. Parents are a child’s first teacher, so perceptions and beliefs held by the parent that are positive and optimistic about math could also help with students’ beliefs and perceptions of math. This could help especially with girls since they tend to have negative attitudes and high anxiety levels toward math.

Teacher educators and school administrators are consistently looking for ways to help students make progress in their education. A way to help students’ academic progress is to encourage parental involvement in students’ math learning and provide parents with tools to help their children at home with the math assignments they bring home. Another possibility is to develop a math program for parents where they can come to the school on the evenings and be taught the lessons their child would be learning in the math class. Students may see the effort their parents are putting in to learn the same information and have increased motivation to do better in math. In addition, their parents would be able to better help them on the specific math concepts students would be learning in class.

Teacher educators and school administrators may also want to use the research findings of students' math performance to help in looking into multiple ways to teach. In this study, students' math performance scores increased in a short amount of time whether they were in the experimental or control group. Although both groups did improve about the same, even with an intervention, both groups improved and that is important. Students' experiences help them to become actively involved in their learning according to Piaget. Therefore, Brainingcamp was beneficial to the students in the experimental because a large number of students reported how helpful it was to their understanding and processing of the information learned.

The teaching methods that teacher educators use are essential. It is important for teachers to apply student learning of math with real life situations. When students know the importance of math, the importance of the specific math concepts they are learning and how it applies to their life, it can increase their attitudes toward math specifically how they value math in life.

The results of the study can also show teacher educators and school administrators the type of educational technology that can be used in conjunction with the teaching methods currently used. The findings of Zhang (2005) and Rivet (2001) revealed that the purpose of computer-assisted technology is to enhance student learning in math. Vygotsky's Zone of Proximal Development helps explain this interaction.

Recommendations

The following recommendations are for teacher educators and school administrators based on the results and conclusion of the study as well as the future research.

Teacher Educators and School Administrators

Teacher educators are encouraged to use multiple instructional styles that are effective for students' learning and increasing their math performance. The literature review in this study along with the results of this study have revealed the effectiveness of using some type of computer-assisted technology to help with students' math performance, especially online technology tools that are visual and interactive. In addition, due to the findings based on students responses of their experience and the improvements made on math performance, the program could be a candidate of consideration to be implemented into the math classroom.

Future Research

The following recommendations are suggested for future research on online visual interactive technological tools. There should be an increase in the number of participants involved. This can be conducted by including other middle schools and grade levels which can provide more generalizability of the results.

The second recommendation could be to assess the effects of an online visual interactive technological tool with students who are at-risk. Students who are at risk tend to have low math achievement which could be due to anxiety (Bai, 2010). Rapid change without proper guidance or transition into abstraction of math before they are developmentally ready may set them up for math anxiety that will have a negative impact throughout their schooling. Research could serve as a way to find out what specific concept in math is causing the math anxiety.

Another recommendation for future research would be to assess the effects of an online visual interactive technological on elementary students' basic math skills, preferably 4^{th} and 5^{th} grade students. In order for students to apply and use math fluently and correctly, a strong foundation of basic math skills is essential (Jordan et al., 2009). Peter, Glück, and Beiglböck (2010) stated that according to Piaget, constant practice with engaging experiences helps with children's cognitive development.

The fourth recommendation could be to incorporate a qualitative aspect to understand the decrease in students' self-confidence and motivation attitudes toward math. This could be information to support quantitative data. Incorporation of parental involvement in students' math performance in relation to their attitudes toward math should be evaluated.

The final recommendation is to increase the amount of time of the study. Most studies occur for a longer duration of time. Although students in both groups improved on their math performance in the current study, a longer intervention time could influence the findings.

Summary

This study investigated whether an online and interactive technological tool could be utilized in the 6th grade classroom to increase students' math performance in conjunction with reducing students' math anxiety and increasing their positive attitudes/perceptions of math. This chapter summarized the study and included the discussion of the findings within the study. Limitations of the study were provided along with implications and recommendations for parents and teachers as well as suggestions for future research.

REFERENCES

Agenda for Action: Problem Solving (2012). Retrieved June 13, 2012, from National Council for Teachers of Mathematics: http://www.nctm.org/standards/content.aspx?id=17279

Algarabel, S., & Dasi, C. (2001). The definition of achievement and the construction of tests for its measurement: A review of the main trends. *Psicológica, 22*, 43-66.

Anderson, K. J., & Minke, K. M. (2007). Parent involvement in education: Toward an understanding of parents' decision making. *The Journal of Educational Research, 100*(5), 311-323.

Arroyo, I., Royer, J. M., & Woolf, B. P. (2011). Using an intelligent tutor and math fluency training to improve math performance. *International Journal of Artificial Intelligence in Education, 21*(1-2), 135-152.

Ashcraft, M. H. (2002). Math anxiety: Personal, educational, and cognitive consequences. *Current Directions in Psychological Science, 11*(5), 181-185.

Bai, H. (2010). Cross-Validating a bidimensional mathematics anxiety scale. *Assessment, 1*, 178-182.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. Psychological Review, 84(2), 191-215. doi:10.1037/0033-295X.84.2.191.

Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. Englewood Cliffs, NJ: Prentice Hall.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.

Batton, M. (2010). *The effect of cooperative groups on math anxiety*. (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database. (PQDT: 787907070)

Boaler, J. (2008). *What's math got to do with it? Helping children learn to love their least favorite subject and why it's important for America*. New York: Penguin Group.

Bottge, B. A., Rueda, E., Kwon, J. M., Grant, T., LaRoque, P. (2009). Assessing and tracking students' problem solving performances in anchored learning environments. *Educational Technology Research and Development, 57*, 529-552. doi: 10.1007/s11423-007-9069-y

Brainingcamp. (2010). Product. Retrieved from http://brainingcamp.com/product/what-is-it.html

Brogan, D. T. (2010). *Stuck in the middle: Career progress, motivation, and engagement among urban middle school students.* (Boston College). *ProQuest Dissertations and Theses*, Retrieved from http://ezproxy.twu.edu:2048/login?url=http://search.proquest.com/docview/250888541?accountid=7102

Brown, R., Brown, J., Reardon, K., & Merrill, C. (2011). Understanding STEM: Current perceptions. *Technology and Engineering Teacher*, 5-9.

Butler, D. L., Beckingham, B., & Novak Lauscher, H.J. (2005) Promoting strategic learning by eighth-grade students struggling in mathematics: A report of three cases. *Learning Disabilities Research & Practice*, *20*(3), 156-174.

Chard, D. J., Baker, S. K., Clarke, B., Jungjohann, K., Davis, K., & Smolkowski, K. (2008). Preventing early mathematics difficulties: The feasibility of a rigorous kindergarten mathematics curriculum. *Learning Disability Quarterly, 31*(1), 11-20.

Clarke, D. M. (1997) The changing role of the mathematics teacher. *Journal for Research in Mathematics Education*, *28*(3), 278- 308.

Collis, B. (1987). Sex differences in the association between secondary school students' attitudes towards mathematics and towards computers. *Journal for Research in Mathematics Education*, *18*(5), 394-402.

Denzin, N. K., & Lincoln, Y. S. (Eds.). (2005). *The sage handbook of qualitative research*. Thousand Oaks, CA: Sage.

Deslandes, R., & Bertrand, R. (2005). Motivation of parent involvement in secondary-level schooling. *The Journal of Educational Research, 98*(3), 164-174.

Dia, D. A., & Bradshaw, W. (2008). Cognitive risk factors to the development of anxiety and depressive disorders in adolescents. *Child and Adolescent Social Work Journal*, *25*(6), 469-481.

Eisenhart, M., Borko, H., Underhill, R., Brown, C., Jones, D., & Agard, P. (1993). Conceptual knowledge falls through the cracks: Complexities of learning to teach mathematics for understanding. *Journal for Research in Mathematics Education, 24*(1), 8-40.

Ellis, M. W., & Berry, R. Q. (2005). The paradigm shift in mathematics education: Explanations and implications of reforming conceptions of teaching and learning. *The Mathematics Educator, 15*(1), 7-17

Else-Quest, N.M., Hyde, J.S., & Linn, M.C. (2010). Cross-national patterns of gender differences in mathematics: A meta-analysis. *Psychological Bulletin, 136*(1), 103-127

Entwisle, D. R., & Alexander, K. L. (1990). Beginning school math competence: Minority and majority comparisons. *Child Development, 61*(2), 454-471

Fan, L., & Zhu, Y. (2007). Representation of problem-solving procedures: A comparative look at China, Singapore, and US mathematics textbooks. *Educational Studies in Mathematics, 66*(1), 61-75.

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behavior Research Methods, 39, 175-191.

Forster, N., & Souvignier, E. (2011). Curriculum-based measurement: Developing a computer-based assessment instrument for monitoring student reading progress on multiple indicators. *Learning Disabilities: A Contemporary Journal, 9*(2), 65-88.

Ginsburg, H.P., Jacobs, S.F., & Lopez, L.S. (1993). Assessing mathematics thinking and learning potential in primary grade children. *Investigations into Assessment in Mathematics Education*, 157-167.

Graham, S., Taylor, A. Z., & Hudley, C. (1998). Exploring achievement values among ethnic minority early adolescents. *Journal of Educational Psychology, 90*(4), 606-620.

Greenwood, M. R.C. & North K.K. (1999). Science through the looking glass: Winning the battles but losing the war? *Science, 286*(5447), 2072 - 2078 DOI: 10.1126/science.286.5447.2072

Grover, R. L., Ginsburg, G. S., & Ialongo, N. (2005). Childhood predictors of anxiety symptoms: A longitudinal study. *Child Psychiatry and Human Development, 32*(6), 133-153.

Gutstein, E. (2007. Connecting community, critical, and classical knowledge in teaching mathematics for social justice. *The Montana Mathematics Enthusiast, ISSN 1551-3440, Monograph 1*, 109-118

hacker. 2012. In *Merriam-Webster.com*. Retrieved July 19, 2012, from http://www.merriam-webster.com/dictionary/hacker

Haladyna, T., Shaughnessy, J., & Shaughnessy, J. M. (1983). A causal analysis of attitude toward mathematics. *Journal for Research in Mathematics Education, 14*(1), 19-29.

Hall, L. (2009). *Problem solving and creativity: A gender and grade level comparison.* (Tennessee State University). *ProQuest Dissertations and Theses*, Retrieved from http://ezproxy.twu.edu:2048/login?url=http://search.proquest.com/docview/305124283?accountid=7102

Haycock, K. (2001). Helping all students achieve: Closing the achievement gap. *Educational Leadership, 58*(6), 1-15.

Henderson, R. W., & Landesman, E. M. (1992). Mathematics and middle school students of Mexican descent: The effects of thematically integrated instruction. UC Berkeley: Center for Research on Education, Diversity and Excellence. Retrieved from: http://www.escholarship.org/uc/item/13k5q2f9

Hiebert, J., Stigler, J. W., Jacobs, J. K., Givvin, K. B., Garnier, H., Smith, M., Hollingsworth, H., Manaster, A., Wearne, D., & Gallimore, R. (2005). Mathematics teaching in the United States today (and tomorrow): Results from the TIMSS 1999 video study. *Educational Evaluation and Policy Analysis, 27*(2), 111-132.

Ho, H.Z., Senturk, D., Lam, A.G., Zimmer, J.M., Hong, S., Okamoto, Y. & Chiu, S.Y. (2000). The affective and cognitive dimensions of math anxiety: A cross-national study. *Journal for Research in Mathematics Education, 31*(3), 262-279.

Holloway, J. H. (2004). Closing the minority achievement gap in math. *Educational Leadership*, *61*(5), 84-86.

Hoy, W. K., Tarter, C. J., & Hoy, A. W. (2006). Academic optimism of school: A force for student achievement. *American Educational Research Journal, 43*(3), 425-446.

Interactive. (2007). Retrieved June 13, 2012, from V2 Vocabulary Building Dictionary website: http://vocabulary-vocabulary.com/dictionary/interactive.php

Johnson, C., & Kritsonis, W. (2006). The achievement gap in mathematics: A significant problem for African American students. Retrieved from ERIC database. (ED 492139)

Jordan, N. C., Kaplan, D., Olah, L., & Locuniak, M. N. (2006). Number sense growth in kindergarten: A longitudinal investigation of children at risk for mathematics difficulties. *Child Development*, *77*, 153–175.

Jordan, N. C., Kaplan, D., Ramineni, C., & Locuniak, M. N. (2009). Early math matters: Kindergarten number competence and later mathematics outcomes. *Developmental Psychology, 45*(3), 850-867. doi:10.1037/a0014939.

Kanning, R. G. (1994). What Multimedia Can Do in Our Classrooms. *Educational Leadership*, *51*(7), 40-44.

Khatoon, T., & Mahmood, S. (2010). Mathematics anxiety among secondary school students in India and its relationship to achievement in mathematics. *European Journal of Social Sciences, 16*(1), 75-86.

Klibanoff, R.S., Hedges, L. V. & Marina V. (2006). Preschool Children's Mathematical Knowledge: The Effect of Teacher "Math Talk." *Developmental Psychology, 42*(1), 59-69.

Koedinger, K. R., McLaughlin, E. A., & Heffernan, N. T. (2010). A quasi-experimental evaluation of an on-line formative assessment and tutoring system. *Journal of Educational Computing Research*, *43*(4), 489-510.

Krinzinger, H., Kaufmann, L., & Willmes, K. (2009). Math anxiety and math ability in early primary school years. *Journal of Psychoeducational Assessment, 27*(3), 206-225. doi:10.1177/0734282908330583.

Kuhn, T. (1970). *The structure of scientific revolutions*. Chicago Press: Chicago and London

Ladson-Billings, G. (1997). It doesn't add up: African-American students' mathematics achievement. *Journal of Research in Mathematics Education*, *23*(6), 697-708.

Lee, J. (2002). Racial and ethnic achievement gap trends: Reversing the progress toward equity. *Educational Researcher, 31*(1), 3-12.

Lee, J. S., & Bowen, N. K. (2006). Parent involvement, cultural capital, and the achievement gap among elementary school children. *American Educational Research Journal*, *43*(2), 193-218.

Lee, J., & Fish, R. M. (2010). International and interstate gaps in value-added math achievement: Multilevel instrumental variable analysis of age effect and grade effect. *American Journal of Education, 117*(1), 109-137.

Lerman, S. (1996). Intersubjectivity in mathematics learning: A challenge to the radical constructivist paradigm? *Journal for Research in Mathematics Education*, *27*(2), 133-150

Lubienski, S. T. (2000) Problem solving as a means toward mathematics for all: An exploratory look through a class lens. *Journal for Research in Mathematics Education*, *31*(4), 454- 482.

Lubienski, S. T. (2002). A closer look at black-white mathematics gaps: Intersections of race and SES in NAEP achievement and instructional practices data. *Journal of Negro Education, 71*(4), 269-287.

Ma, X. (1999). A meta-analysis of the relationship between anxiety toward mathematics and achievement in mathematics. *Journal for Research in Mathematics Education, 30*(5), 520-540.

Malloy, C.E. & Jones, M.G. (1998). An investigation of African-American students' mathematical problem solving. *Journal of Research in Mathematics Education, 29*(2), 143-163.

Martin, D.B. (2006) Mathematics learning and participation as racialized forms of experience: African American parents speak on the struggle for mathematics literacy. *Mathematical Thinking and Learning*, *8*(3), 197-229.

Math Standards and Expectations (2012). Retrieved May 8, 2012, from National Council for Teachers of Mathematics: http://www.nctm.org/standards/content.aspx?id=4294967312

Mazzocco, M. M., & Devlin, K. T. (2008). Parts and "holes": Gaps in rational number sense among children with vs. without mathematical learning disabilities. *Developmental Science, 11*(5), 681-691.

McClanahan, B., Williams, K., Kennedy, E., & Tate, S. (2012). A breakthrough for Josh: How use of an iPad facilitated reading improvement. *Techtrends: Linking Research and Practice to Improve Learning*, *56*(3), 20-28.

Meadows, S. (2006). *The child as thinker* (2nd ed.). NY: Routledge.

Mendicino, M., Razzaq, L., & Heffernan, N. T. (2009). A comparison of traditional homework to computer-supported homework. *Journal of Research on Technology in Education, 41*(3), 331-359.

Mertler, C. A., & Vannatta, R. A. (2010). Advanced and multivariate statistical methods (4th ed.). Glendale, CA: Pyrczak Publishing.

Middleton, J.A. & Spanias, P.A. (1999). Motivation for achievement in mathematics: Findings, generalizations, and criticisms of the research. *Journal for Research in Mathematics Education, 30*(1), 65-88.

Montague, M., & van Garderen, D. (2003). A cross-sectional study of mathematics achievement, estimation skills, and academic self-perception in students of varying ability. *Journal of Learning Disabilities*, *36*(5), 437-448.

Moss, M. (2004). Visualizing history: Computer technology and the graphic presentations of the past. *College Quarterly*, *7*(1), 1-14.

National Center for Education Statistics. (2009, September 3). The NAEP mathematics achievement levels. Retrieved from http://nces.ed.gov/nationsreportcard/mathematics/achieve.asp

Nazzal, A. (2011). Racial differentiation in practice: An exploration of first year teacher implementation of differentiation strategies as expected outcomes of teacher preparation program. *Current Issues in Middle School Education, 16*(1), 17-27.

Newstead, K. (1998). Aspects of children's mathematics anxiety. *Educational Studies in Mathematics, 36*(1), 53-71.

Nugent,G., Kunz, G., Rilett, L., & Jones, E. (2010). Extending engineering education to K-12. *The Technology Teacher*, 14-19.

Odom, R. (2010). *Cooperative learning: Middle school students' math perceptions.* (Walden University). *ProQuest Dissertations and Theses,* Retrieved from http://ezproxy.twu.edu:2048/login?url=http://search.proquest.com/docview/816337964?accountid=7102

Ogbuehi, P. I., & Fraser, B. J. (2007). Learning environment, attitudes and conceptual development associated with innovative strategies in middle-school mathematics. *Learning Environmental Research*, *10*, 101-114. doi: 10.1007/s10984-007-9026-z

Orabuchi, I. I. (1992). *Effects of using interactive CAI on primary grade students' higher-order thinking skills: Inferences, generalizations, and math problem-solving.* (Texas Woman's University). *ProQuest Dissertations and Theses,* 134 p. Retrieved from http://ezproxy.twu.edu:2048/login?url=http://search.proquest.com/docview/304016626?accountid=7102

Pearson Education. (2003). *Glossary*. Retrieved from http://www.eszes.net/eLibrary/glossary.htm#D

Peterson, P. E., Woesmann, L., Hanushek, E. A., & Lastra-Anadon, C. X. (2011, August). *Globally challenged: are U.S. students ready to compete? The latest on each state's international standing in math and reading.* Program on Education Policy and Governance, Harvard University. Retrieved from ERIC database. (ED526954)

Piaget, J. (1959). *Language and thought of the child.* (3rd ed). London: Routledge & Kegan Paul Ltd.

Piaget, J. (1968). *Six psychological studies.* New York: Random House, Inc.

Piaget, J. (1972). Intellectual evolution from adolescence to adulthood. In R. M. Lerner & J. Jovanovic (Eds.), *Cognitive and Moral Development, Academic Achievement*. New York: Taylor and Francis, Inc. Retrieved April 28, 2011, from http://books.google.com/books?hl=en&lr=&id=ZmsOowY6-9YC&oi=fnd&pg=PA1&dq=piaget+stages+of+cognitive+development&ots=vLU6S1A4Vr&sig=MH4613KeFaY0zk5yBc5SXEpQUFs#v=onepage&q=piaget%20stages%20of%20cognitive%20development&f=false

Porter, A., McMaken, J., Hwang, J., & Yang, R. (2011). Assessing the common core standards: Opportunities for improving measures of instruction. *Educational Researcher, 40*(4), 186-188.

Project Tomorrow (2011). The three new E's of education: Enabled, engaged, empowered, how today's students are leveraging emerging technologies for learning. *Speak Up 2010 National Findings,* 1-18. Retrieved from www.tomorrow.org/speakup

Putwain, D. (2007). Researching academic stress and anxiety in students: Some methodological considerations. *British Educational Research Journal, 33*(2), 207-219.

Riffert, F. 2005. "The use and misuse of standardized testing: A Whiteheadian point of view." *Interchange, 36*(1-2), 231-252.

Rittle-Johnson, B., & Koedinger, K. R. (2005). Designing knowledge scaffolds to support mathematical problem solving. *Cognition and Instruction*, *23*(3), 313-349.

Rivet, J. R. (2001). *Student achievement in middle school mathematics: Computer-assisted instruction versus traditional instruction.* (University of Southern California). *ProQuest Dissertations and Theses,* 169 p. Retrieved from http://ezproxy.twu.edu:2048/login?url=http://search.proquest.com/docview/276130330?accountid=7102

Roksa, J., & Potter, D. (2011). Parenting and academic achievement: Intergenerational transmission of educational advantage. *Sociology of Education*, *84*(4), 299-321. doi:10.1177/0038040711417013

Roschelle, J. M., Pea, R. D., Hoadley, C. M., Gordin, D. N., & Means, B. M. (2000). Changing how and what children learn in school with computer-based technologies. *The Future of Children, 10*(2), 76-101.

Rothman, R. (2012). A common core of readiness. *Educational Leadership, 69*(7), 10-15.

Schaub, M., & Baker, D. P. (1991). Solving the math problem: Exploring mathematics achievement in Japanese and American middle grades. *American Journal of Education*, *99*(4), 623-642.

Schielack, J., & Seeley, C. L. (2010). Transitions from elementary to middle school math. *Teaching Children Mathematics, 16*(6), 358-362. Retrieved from http://www.nctm.org

Schneider, M., Grabner, R. H., & Paetsch, J. (2009). Mental number line, number line estimation, and mathematical achievement: Their interrelations in grades 5 and 6. *Journal of Educational Psychology*, *101*(2), 359-372.

Schoenfeld, A. H. (1992). Learning to think mathematically: Problem solving, metacognition, and sense-making in mathematics. In D. Grouws (Ed.), *Handbook for Research on Mathematics Teaching and Learning* (pp. 334-370). New York: MacMillan.

Schoenfeld, A. H. (2002). Making mathematics work for all children: Issues of standards, testing, and equity. *Educational Researcher*, *31*(1), 13-25.

Shores, M. L., Smith, T. G., & Jarrell, S. L. (2009). Do individual learner variables contribute to differences in mathematics performance. *SRATE Journal 18*(2), 1-8.

Smith, T. M., Desimone, L. M., & Ueno, K. (2005). "Highly qualified" to do what? The relationship between NCLB teacher quality mandates and the use of reform-oriented instruction in middle school mathematics. *Educational Evaluation and Policy Analysis*, *27*(1), 75-109.

Stanic, G. M. A. (1989). Social inequality, cultural discontinuity, and equity in school mathematics. *Peabody Journal of Education, 66*(2), 57-71.

Suh, J. M. (2010). Tech-knowledgy & diverse learners. *Mathematics Teaching in the Middle School, 15*(8), 440-447.

Tapia, M., & Marsh, G. E. (2004). An instrument to measure mathematics attitudes. *Academic Exchange Quarterly, 8*(2), 16-21.

Tate, W. F. (1997). Race-ethnicity, SES, gender, and language proficiency trends in mathematics achievement: An update. *Journal for Research in Mathematics Education*, *28*(6), 652-679.

Technology Focus Strand (2012). Retrieved June 13, 2012, from National Council for Teachers of Mathematics: http://www.nctm.org/technology/#overview

Terrell, N. (2007). STEM occupations. *Occupational Outlook Quarterly,* 26-33.

Texas Education Agency (2007). Chapter 16. Reliability. Retrieved from http://www.tea.state.tx.us/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=2147494031&libID=2147494028

Texas Education Agency (2007). Chapter 17. Validity. Retrieved from http://www.tea.state.tx.us/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=2147494000&libID=2147493997

Texas Education Agency (2009, February 23). Chapter 111. Texas essential knowledge and skills for mathematics: Subchapter B. middle school. Retrieved from http://ritter.tea.state.tx.us/rules/tac/chapter111/ch111b.html

Texas Education Agency. (2009). *Texas education agency: Growth model pilot application for adequate yearly progress determinations under the No Child Left Behind Act.* Retrieved June 26, 2012, from www.tea.state.tx.us/student.assessment/measures/Measure-011209-USDE-GrowthProposalTX.pdf

Texas Education Agency. (2011). TAKS resources. Retrieved June 26, 2012, from http://www.tea.state.tx.us/student.assessment/taks/

Thomasian, J. (2011). *Building a science, technology, engineering, and math education agenda: An update of state actions.* Retrieved from ERIC database. (ED532528)

Turney, K., & Kao, G. (2009). Barriers to school involvement: Are immigrant parents disadvantaged? *The Journal of Educational Research*, *102*(4), 257-271.

U.S. Department of Education. (2009). The facts about…math achievement: Archived information. Retrieved May 10, 2012, from http://www2.ed.gov/nclb/methods/math/math.html

Vygotsky, L. (1978). Interaction between learning and development. Mind and Society, (79-91). Cambridge, MA: Harvard University Press.

Vygotsky, L. S. (1986). *Thought and language.* Cambridge, MA: MIT Press.

Woolfolk, A., & Perry, N. E. (2012). *Child and adolescent development*. Upper Saddle River, NJ: Pearson Education.

Zhang, Y. (2005). *An experiment on mathematics pedagogy: Traditional method versus computer-assisted instruction.* Retrieved from ERIC database. (ED490695)

Zucker, A. A. (2006). Development and testing of math insight software. *Journal of Educational Technology Systems, 34*(4), 371-386.

APPENDIX A

Consent Form (English)

TEXAS WOMAN'S UNIVERSITY
CONSENT TO PARTICIPATE IN RESEARCH

Title: Effects of Online Visual and Interactive Technological Tool (OVITT) on Early Adolescent Students' Mathematics Performance, Math Anxiety, and Attitude toward Math

Investigator: Nkechi Orabuchi .... norabuchi@twu.edu 940/369-2440
Advisor: Lin Moore, PhD .... lmoore@twu.edu 940/898-2210

Explanation and Purpose of the Research

You and your child are being asked to participate in a research study for Ms. Orabuchi's dissertation at Texas Woman's University. The purpose of the study is to investigate whether the use of an online and interactive technological tool being used in the 6th grade classrooms will improve students' math performance, reduce students' math anxiety and increase their attitudes/perceptions of math. Your child has been asked to participate in this study because they are a 6th grade student. You are being asked to participate because you are the parent of the 6th grade student and we believe your family demographic information will contribute to this study.

Description of Procedures

Parent participation will be limited to completing the family demographic information after signing this consent form.

Student participation involves their normal classroom activities. Every 6th grade student will receive regular math instruction time for 45 minutes on Mondays and 90 minutes each day on Tuesday through Friday during the fall semester, August through December. The math teachers will plan to teach the same math concepts following the 6th grade math Texas Essential Knowledge and Skills (TEKS) using similar teaching strategies, including group activities, individual work, think-pair-share (partners), and the use of manipulatives. All of these are part of normal classroom activities.

All 6th grade students will also be exposed to an online math program (Brainingcamp). Brainingcamp is an online visual and interactive technological tool/program designed to help with engagement and problem solving skills in math. As a way of testing the efficacy of this program, some students in the fall semester will use Brainingcamp and other students in the spring semester will use Brainingcamp (or an equal program). The Brainingcamp program will be used in a computer lab for 45 minutes, twice a week during the regularly scheduled instructional time.

State mandated tests will take place early in September. The released items from the 2009 Texas Assessment of Knowledge and Skills (TAKS) math test will be administered to the 6th grade students to assess their math performance. The time necessary to complete the TAKS measures will be one class session of 90 minutes each for the pretest and posttest. Teacher-facilitated student assessments will also be administered: The Math Anxiety Scale Revised (MAS-R) will assess student math anxiety and the Attitudes Towards Math Inventory (ATMI) will assess their attitudes towards math.

____
Initials

The time necessary to complete both the MAS-R and ATMI measures will be one class session of 90 minutes for the pretest and posttest. Because the MAS-R and ATMI measures are used to assess student anxiety and attitudes about math, the teachers already use this data to facilitate adjustments to teaching strategies. Although not state mandated, these measures are also a part of normal classroom activities.

State mandated tests will take place again in December. All of the same tests will be administered and the time allocations will be the same as the previous tests.

Potential Risks

The researcher will ask questions regarding your family demographic information. A possible risk is loss of time. Students and parents may lose time while reading, discussing, and completing the consent forms and family information forms. The family forms will limit time loss through a simple checklist format.

Another risk is loss of confidentiality. Confidentiality will be protected to the extent that is allowed by law. Students and parents will be assigned ID numbers. Family demographic information forms and test results will be recorded using these ID numbers; no names will be used in summaries of the research findings. The TAKS tests, the MAS-R and ATMI surveys, and the family demographic information forms will be stored in a locked cabinet in the researcher's office. Only the researcher and the advisor will have access to the information gathered.

Another possible risk is coercion. Participation in the study is voluntary and agreeing to let the researcher use your information will not impact your child's regular classroom experiences. Parents and students may withdraw from the study at any time. All students enrolled in 6th grade math classes at the school will receive regular classroom math instruction.

Other possible risks include loss of regular instructional time and a possible decrease in math performance. However, these risks will be minimized because the Brainingcamp program activities will be used to align with regular instructional objectives. In addition, students' math performance will be monitored daily with adjustments made to support their math achievement.

The researchers will try to prevent any problem that could happen because of this research. You should let the researchers know at once if there is a problem and they will help you. However, TWU does not provide medical services or financial assistance for injuries that might happen because you are taking part in this research.

Participation and Benefits

Allowing for use of you and your child's information for this study is completely voluntary. You and your child may withdraw permission for use of your data at any time. Your child will continue to receive the lessons and teaching in the math classroom during their regular classroom activities regardless of whether or not you allow us to use your data.

A summary of the findings will be distributed to all students in the spring.

The benefit of this study is to contribute to the knowledge of the field of child development and education. Students learn in different ways and being able to research how to enhance and engage students in math problem solving would help students with their learning in the classroom and be able to apply the math knowledge gained in their daily lives. The findings may be useful to math teachers in planning instruction for 6th grade students.

Questions Regarding the Study

You will be given two copies of this consent form. Please sign one copy and return and keep the other. Questions may be asked at any time during the study. If you have any questions about the research study you should ask the researchers; their phone numbers are at the top of this form. If you have questions about your child's rights as a participant in this research or the way this study has been conducted, you may contact the Texas Woman's University Office of Research and Sponsored Programs at 940-898-3378 or via e-mail at IRB@twu.edu.

If you agree to allow the researcher to use you and your child's data in the study, please sign below and have your child sign below. If you and your child agree to participate, please also fill out the family demographic information form attached. Please return one copy of the consent form and the family demographic information form in a sealed envelope to your child's math teacher.

____

Signature of Participant's Parent/Guardian Date

The study presented above has been explained to me and any questions I had have been answered. I would like to take part in the study.

____

Signature of Student Participant

____

Initials

APPENDIX B

Consent Form (Spanish)

TEXAS WOMEN'S UNIVERSITY

CONSENTIMIENTO PARA PARTICIPAR EN UNA INVESTIGACION

Titulo: Efectos de en linea, herramienta tecnologica visual e interactiva en la adolescencia temprana. Rendimiento, anciedad, y actitud del estudiante hacia las matematicas.

Investigador: Nkechi Orabuchi.................................. norabuchi@twu.edu 940/369-2400

Consejero: Lin Moore, PhD..lmoore@twu.edu 940/898-2210

Explicasion y proposito de el studio

Usted y su hijo están siendo invitados a participar en un estudio de investigación para la disertacion de Ms. Orabuchi en Texas Woman's University. El proposito del studio es investigar si el uso de en linea y la herramienta tecnologica interactiva siendo utilizada en el grado seis mejorara el rendimiento matematico, reducira la anxiedad de los estudiantes y aumentara sus actitudes/percepciones de matematicas. Su hijo ha sido invitado a participar en este studio por que esta en sexto grado. Usted ha sido invitado a participar por que es el padre del estudiante y creemos que la información demográfica de su familia va a contribuir a este studio.

Descripcion de los procedimientos

La participación de los padres sera limitada al completar la información demográfica de las familias después de firmar este consentimiento.

La participación de los alumnos implica su actividad normal en la escuela. Cada estudiante del grado seis recivira instruccion regular de matematica por 45 minutos los lunes y 90 minutos cada otro dia los martes hasta los viernes durante el semester de otoño, desde agosto hasta diciembre. Los profesores de matematicas planearan enseñar los mismos conceptos en matematicas, siguiendo los conocimientos y habilidades esenciales de Texas (TEKS) y usando estrategias similares para enseñar, incluyendo actividades en grupos, trabajos individuales,pensar, compartir (socios), y el uso de manipulativos todos estos elementos son parte de las actividades en la clase normal.

Todos los estudiantes también serán expuestos a un programa de matemáticas en línea brainingcamp que es una herramienta tecnológica visual e interativa
Diseñada para ayudar a estudiantes a que se enfoquen y tengan habilidad de resolver problemas en matemáticas. Como una forma de poner a prueba la eficacia de este programa algunos estudiantes en el semestre de otoño utilizaran brainingcamp y otros estudiantes en el semestre de primavèra utilizarán brainingcamp o (otro programa igual) El programa de brainingcamp se utilizara en el laboratorio de computadoras por 45 minutos, dos veces por semana durante el horario regular de instruccion.
Por mandato de Estado las pruebas tendrá lugar a principios de septiembre. Los artículos retirados de texas 2009 hechos de conocimientos y habilidades (TAKS) matematicas se administran a los estudiantes de grado seis para evaluar su rendimiento. El tiempo necesario para completar las medidas de TASKS serán una sesión de clase de 90 minutos cada una, antes del examen y despues

Approved by the
Texas Woman's University
Institutional Review Board
Date: 9-25-12

del examen. Maestros facilitandos tambien administraran evaluaciones. La escala de ansiedad matemática revisada (MAS-R) evaluara la ansiedad matemática del estudiante, y las actitudes del estudiante hacia las matemáticas seran revisadas por (ATMI).

El tiempo necesario para completar esta medidas MAS-R y ATMI será una sesión de clase de 90 minutos antes y despues de la evaluacion porque el MAS-R y el ATMI se utilizan para evaluar ansiedad estudiantil y actitudes hacia la matemática, los maestros que ya utilizan esta información facilitan ajustes para estrategias de enseñanza. Aunque no es un mandato del estado encargado, estas medidas tambien son parte de la actividad normal de la clase.

Mandato de estado las pruebas tendrá lugar nuevamente en diciembre. Todas las mismas pruebas serán administradas y la hora y el lugar sera igual que las pruebas anteriores.

Riesgo Potencial

El investigador hara preguntas con respecto a su familia e información demográfica. un posible riesgo es la pérdida de tiempo. Los estudiantes y los padres pueden perder el tiempo mientras discuten y completan los formularios de consentimiento y la información de la familia. Las formas de la familia limitará pérdida de tiempo a través de un sencillo formato de lista.

Otro riesgo es la pérdida de confidencialidad. La confidencialidad será protegida en la medida en que este permitido por la ley. Se le asignara números de identificación a los estudiantes y padres. La información demográfica de las familias formas y resultados de las prueba serán grabadas utilizando estos números de identificacion. No se usaran nombres en los resúmenes de los resultados de la investigación. Los examen del TASK, los estudios de MAS-R, ATMI y tambien la informacion demografica de las familias sera guardada bajo llave en la oficina de investigaciones y solo el investigador y el consejero tendran asceso a esta informacion recopilada.

Otro posible riesgo es coersion. La participación en el estudio es voluntaria y aceptar que el investigador usara su información no afectará las experiencias en las clases regulares de su niño. Todos los estudiantes registrados para clases de matematicas del grado seis reciviran instruccion regular de matematica en su clase.

Otros posibles riesgos son la pérdida de tiempo de instrucción regular y una posible disminución en el rendimiento matemático. Sin embargo, estos riesgos se minimizan debido a las actividades del programa Brainingcamp se utiliza para alinear con los objetivos de instrucción regulares. Además, el rendimiento de los estudiantes de matemáticas será monitoreado a diario con los ajustes hechos para apoyar su rendimiento en matemáticas.

El investigador tratara de evitar cualquier problema que ocurra por esta investigacion. Usted debe avisar al investigador si hay algun problema para que ellos le ayuden. sin embargo, TWU no proporciona servicios médicos o de asistencia financiera por los daños que podrían suceder por que usted esta tomando parte en esta investigacion.

Participacion y beneficios

Darnos autorizacion para usar su información y la de su hijo para este estudio es completamente voluntario. Usted y su niño pueden retirar esa autorizacion en cualquier momento. Su hijo continuará reciviendo las lecciones y la enseñanza de las matemáticas durante la clase aunque usted permita o no que usemos sus datos.

Un resumen de las conclusiones sera distribuido a todos los alumnos en la primavera.

La ventaja del estudio es contribuir al conocimiento del campo de desarrollo del niño y la educación. Los estudiantes aprenden de distintas maneras y ser capaz de investigar como realzar la manera de atraer a los estudiantes hacia las matematicas, a solucionar problemas, ayudarlos con su aprendizaje en la clase, para que sean capaces de aplicar conocimientos adquiridos en su vida diaria. Los resultados adquiridos pueden ser de utilidad a los maestros en la planificación de sus lecciones de matemáticas para estudiantes del grado seis.

Preguntas sobre el studio

Se le daran dos copias de este consentimiento. Por favor firmar una copia y devolver y guardar la otra. Preguntas se pueden hacer en cualquier momento durante el studio. Si usted tiene cualquier pregunta sobre el estudio de investigación debe hablar con los investigadores; sus números de teléfono están en la parte superior del formulario. Y si tiene preguntas sobre los derechos de su hijo/ja como participante en ésta investigación o en la forma en que este estudio se ha realizado, usted puede ponerse en contacto con la oficina de investigación y programas patrocinados de Texas woman's University al (940)898-3378 o por correo electronico a IRB@twu.edu.

Si esta de acuerdo en que el investigador use sus datos y los de su hijo/hija en el estudio por favor firme a continuación y su hijo firma abajo. Si usted y su niño estan de acuerdo en participar, por favor llenen la forma adjunta de información demográfica de la familia. Por favor devuelba una copia del consentimiento y de la forma de información demográfica de la familia en un sobre sellado al maestro de matematicas de su hijo/hija.

____

Firma del padre o guardian participante　　　　　　Fecha

El studio presentado arriba me ha sido explicado y todas las preguntas que tenia me han sido contestadas. Me gustaria participar en este studio.

____

Firma del estudiante participante　　　　　　Fecha

APPENDIX C

Demographic Information Form (English)

Family Information

Directions: Please check the box for the choice that best represents you, your child, and your family. All information will remain confidential.

1. Gender of 6th Grade Student
   - ☐ Male
   - ☐ Female

2. Ethnicity of 6th Grade Student
   - ☐ Hispanic or Latino
   - ☐ American Indian or Alaska Native
   - ☐ Asian
   - ☐ Black or African American
   - ☐ Native Hawaiian or Other Pacific Islander
   - ☐ White
   - ☐ Biracial (please specify):____________________
   - ☐ Other (please specify):______________________

3. Age at beginning of school year (Aug. 27)
   (example: 10 years, 3 months)

   Years: __________ Months:____________

4. Languages spoken at home
   - ☐ Mostly English
   - ☐ Mostly Spanish
   - ☐ Both English and Spanish
   - ☐ Other languages (please specify) ____________________

5. Relationship to student
   - ☐ Mother
   - ☐ Stepmother
   - ☐ Father
   - ☐ Stepfather
   - ☐ Grandmother
   - ☐ Grandfather
   - ☐ Guardian (aunt, uncle, nonrelative)

6. Education of Parents or Guardians

What is the highest degree or level of school you have completed? If currently enrolled, mark the previous grade or highest degree received.

Education level of mother/stepmother or grandmother as primary caregiver	**Education level of father/stepfather or grandfather as primary caregiver**
☐ Early school to 5th grade	☐ Early school to 5th grade
☐ Middle school (6th-8th grade)	☐ Middle school (6th-8th grade)
☐ High school (9th-12th grade)	☐ High school (9th-12th grade)
☐ 12th grade, no diploma	☐ 12th grade, no diploma
☐ High school graduate - high school diploma or the equivalent (for example: GED)	☐ High school graduate - high school diploma or the equivalent (for example: GED)
☐ Some college credit, but less than 1 year	☐ Some college credit, but less than 1 year
☐ 1 or more years of college, no degree	☐ 1 or more years of college, no degree
☐ Associate degree (for example: AA, AS)	☐ Associate degree (for example: AA, AS)
☐ Bachelor's degree (for example: BA, AB, BS)	☐ Bachelor's degree (for example: BA, AB, BS)
☐ Master's degree (for example: MA, MS, MEng, MEd, MSW, MBA)	☐ Master's degree (for example: MA, MS, MEng, MEd, MSW, MBA)
☐ Professional degree (for example: MD, DDS, DVM, JD)	☐ Professional degree (for example: MD, DDS, DVM, JD)
☐ Doctorate degree (for example: PhD, EdD)	☐ Doctorate degree (for example: PhD, EdD)

7. Household Income

What is your **total** household income?

- ☐ Less than $10,000
- ☐ $10,000 to $19,999
- ☐ $20,000 to $29,999
- ☐ $30,000 to $39,999
- ☐ $40,000 to $49,999

- ☐ $50,000 to $59,999
- ☐ $60,000 to $69,999
- ☐ $70,000 to $79,999
- ☐ $80,000 to $89,999
- ☐ $90,000 to $99,999
- ☐ $100,000 or more

APPENDIX D

Demographic Information Form (Spanish)

Informacion de la familia

Instrucciones: Por favor marque la opcion que mejor represente a su hijo y a su familia toda la informacion sera confidencial.

1. Genero del estudiante de sexto grado
    a. Masculino
    b. Femenino

2. Rasa del estudiante
    a. Hispano o Latino
    b. Indio norteamericano o nativo de Alaska
    c. Asiatico
    d. Negro o afroamericano
    e. Nativo de Hawaii o otros isleños del Pacifico
    f. Blanco
    g. Birracial (por favor especifique)
    h. Otro (por favor especifique)

3. Edad al principio del año escolar agosto 27, por ejemplo 10 años 3 meses.
   Años____ Meses______

4. Lenguaje hablado en casa
    a. Principalmente ingles
    b. Principalmente español
    c. Ambos ingles y español
    d. Otro lenguaje (por favor especifique)

5. Relacion con el estudiante
    a. Madre
    b. Madrastra
    c. Padre
    d. Padrastro
    e. Abuela
    f. Abuelo
    g. Protector (tia, tio, no tienen relacion)

6. Educacion de los padres o o protectores. Cual es el nivel mas alto o titulo que completo?

si actualmente esta matriculado en la escuela marquee el grado mas alto o titulo que haiga recivido.

Nivel de educacion de la madre	**Nivel de educacion del padre**
• Escuela temprana hasta el grado 5	• Escuela temprana hasta el grado 5
• Escuela secundaria grados 6,7,8	• Escuela secundaria grados 6,7,8
• Bachillerato o escuela superior grado 9-12	• Bachillerato o escuela superior grado 9-12
• Grado 12 sin diploma	• Grado 12 sin diploma
• Graduado de la escuela superior/preparatoria con diploma o equivalente GED	• Graduado de la escuela superior/preparatoria con diploma o equivalente GED
• Algun credito de colegio, pero menos de un año	• Algun credito de colegio, pero menos de un año
• Uno o mas años de colegio, sin un titulo	• Uno o mas años de colegio, sin un titulo
• 2 años de diplomado	• 2 años de diplomado
• Una licenciatura	• Una licenciatura
• Una maestria	• Una maestria
• Un doctorado	• Un doctorado

7. Cuales son los ingresos en **total** del hogar?

a. Menos de 10,000
b. 10,000 a 19,999
c. 20,000 a 29,999
d. 30,000 a 39,999
e. 40,000 a 49,999
f. 50,000 a 59,999
g. 60,000 a 69,999
h. 70,000 a 79,999
i. 80,000 a 89,999
j. 90,000 a 99,999
k. 100,000 or more

APPENDIX E

Math Anxiety Scale Revised (MAS-R)

Math Anxiety Scale – Revised (MAS-R)

On the paper, please…

- Circle the appropriate response for all the responses from #1 - #14.

ID Number: ____Date:_______________

1. I find math interesting.

A--------------------B--------------------C--------------------D--------------------E
Not true Slightly true Moderately true Mostly true Very true

2. I get uptight during math tests.

A--------------------B--------------------C--------------------D--------------------E
Not true Slightly true Moderately true Mostly true Very true

3. I think that I will use math in the future.

A--------------------B--------------------C--------------------D--------------------E
Not true Slightly true Moderately true Mostly true Very true

4. My mind goes blank and I am unable to think clearly when doing my math test.

A--------------------B--------------------C--------------------D--------------------E
Not true Slightly true Moderately true Mostly true Very true

5. Math relates to my life.

A--------------------B--------------------C--------------------D--------------------E
Not true Slightly true Moderately true Mostly true Very true

6. I worry about my ability to solve math problems.

A--------------------B--------------------C--------------------D--------------------E
Not true Slightly true Moderately true Mostly true Very true

7. I get a sinking feeling when I try to do math problems.

A--------------------B--------------------C--------------------D--------------------E
Not true Slightly true Moderately true Mostly true Very true

8. I find math challenging.

A--------------------B--------------------C--------------------D--------------------E
Not true Slightly true Moderately true Mostly true Very true

9. Mathematics makes me feel nervous.

A--------------------B--------------------C--------------------D--------------------E
Not true Slightly true Moderately true Mostly true Very true

10. I would like to take more math classes.

A--------------------B--------------------C--------------------D--------------------E
Not true Slightly true Moderately true Mostly true Very true

11. Mathematics makes me feel uneasy.

A--------------------B--------------------C--------------------D--------------------E
Not true Slightly true Moderately true Mostly true Very true

12. Math is one of my favorite subjects.

A--------------------B--------------------C--------------------D--------------------E
Not true Slightly true Moderately true Mostly true Very true

13. I enjoy learning with mathematics.

A--------------------B--------------------C--------------------D--------------------E
Not true Slightly true Moderately true Mostly true Very true

14. Mathematics makes me feel confused.

A--------------------B--------------------C--------------------D--------------------E
Not true Slightly true Moderately true Mostly true Very true

Thank you for completing the Math Anxiety Questionnaire. Please make sure all circled all your answers and return the questionnaire back to your teacher.

APPENDIX F

Attitudes Towards Math Inventory (ATMI)

ATTITUDES TOWARD MATHEMATICS INVENTORY

Directions: This inventory consists of statements about your attitude toward mathematics. There are no correct or incorrect responses. Read each item carefully. Please think about how you feel about each item. Circle the response that most closely corresponds to how the statements best describes your feelings. Use the following response scale to respond to each item.

ID Number: ____Date:________________

1. Mathematics is a very worthwhile and necessary subject.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

2. I want to develop my mathematical skills.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

3. I get a great deal of satisfaction out of solving a mathematics problem.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

4. Mathematics helps develop the mind and teaches a person to think.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

5. Mathematics is important in everyday life.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

6. Mathematics is one of the most important subjects for people to study.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

7. High school math courses would be very helpful no matter what I decide to study.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

8. I can think of many ways that I use math outside of school.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

9. Mathematics is one of my most dreaded subjects.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

10. My mind goes blank and I am unable to think clearly when working with mathematics.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

11. Studying mathematics makes me feel nervous.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

12. Mathematics makes me feel uncomfortable.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

13. I am always under a terrible strain in a math class.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

14. When I hear the word mathematics, I have a feeling of dislike.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

15. It makes me nervous to even think about having to do a mathematics problem.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

16. Mathematics does not scare me at all.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

17. I have a lot of self-confidence when it comes to mathematics.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

18. I am able to solve mathematics problems without too much difficulty.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

19. I expect to do fairly well in any math class I take.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

20. I am always confused in my mathematics class.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

21. I feel a sense of insecurity when attempting mathematics.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

22. I learn mathematics easily.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

23. I am confident that I could learn advanced mathematics.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

24. I have usually enjoyed studying mathematics in school.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

25. Mathematics is dull and boring.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

26. I like to solve new problems in mathematics.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

27. I would prefer to do an assignment in math than to write an essay.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

28. I would like to avoid using mathematics in college.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

29. I really like mathematics.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

30. I am happier in a math class than in any other class.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

31. Mathematics is a very interesting subject.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

32. I am willing to take more than the required amount of mathematics.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

33. I plan to take as much mathematics as I can during my education.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

34. The challenge of math appeals to me.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

35. I think studying advanced mathematics is useful.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

36. I believe studying math helps me with problem solving in other areas.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

37. I am comfortable expressing my own ideas on how to look for solutions to a difficult problem in math.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

38. I am comfortable answering questions in math class.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

39. A strong math background could help me in my professional life.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

40. I believe I am good at solving math problems.

A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

APPENDIX G

Brainingcamp Questionnaire

Name: _________________________Date:___________________Class period_____

Directions: Read the following statements about Brainingcamp and circle agree or disagree.

1. Brainingcamp was easy to navigate through the topics.

   Agree
   Disagree

2. It was easy to understand Brainingcamp's lessons on the topics I was learning.

   Agree
   Disagree

3. The interactive section of Brainingcamp provided me an opportunity to practice the skills I learned about from the lesson.

   Agree
   Disagree

4. When I did not understand a problem, Brainingcamp provided me with some helpful hints on the problem.

   Agree
   Disagree

5. I was able to repeat problems that I did not do well on.

   Agree
   Disagree

6. I was able to see my progress on the different topics I have completed.
   Agree
   Disagree

7. It was confusing when I used the computer.
   Agree
   Disagree

8. It was motivating to my learning when I used the computer.
   Agree
   Disagree

9. Please discuss your experience with Brainingcamp. Was it helpful to your learning? Why or why not?

APPENDIX H

Example Lesson Plan

Middle School **Learning Plan**

Name:	**Date: 11/15/12-11/16/12**
Concept:	
Proportional reasoning solves real world problems.	
Materials, Resources, Manipulative and Technology:	
Paper, pencil, math journals, Introduction to Rates and Unit Rates, Which is the Better Buy?, Ratios, Brainingcamp	
TEKS/ SEs	
6.1B, 6.3B, 6.4A	
Warm-up/Agenda: 5-7 *minutes*	
Bellwork and Minute 12 DUE	
Review: (Previous Day Concept) ***__5-7__ minutes*** ***Include previous vocabulary.***	
Ratios, Equivalent Fractions	
Lesson Objective: (What I will learn today!)	
Students will use ratios to make predictions and represent rates.	
Differentiation Strategies:	
Think-pair-share, justify answer, cooperative learning, and activities	
Unit Question:	
Why do we use a variety of forms to represent relationships?	
Vocabulary: (Introduce throughout lesson.)	

What I must know in order to be successful with the above objective.
Rate, Unit Rate
Lesson: (Direct Instruction, Discovery) ______ ***minutes Include all activities.***
Engage: 10 minutes
• <u>Review with students:</u> What is a ratio? (comparison of two different things) What does it compare? (parts to a whole or two different parts) What are the three ways it can be represented? (as a fraction, using the word "to" or using a colon) Can you set it up as a fraction and find its equivalent form? (yes) • Ok, well today we are working with a similar form of ratios, rates and unit rates. But before we can define the terms, let's plan a meal for the Thanksgiving break. When it comes to shopping, especially with groceries, sometimes we have to make decisions about buying items in bulk or deciding what the better buy would be. Let's look at these two turkeys (show pic of two different sized turkeys). Use Intro to Ratios then Ratios
Explain:
• A **rate** is a ratio comparing two quantities or things, but we use different kinds of units. **What is a unit?** (ex: dollars and pound, miles and hours, etc.) • **Unit rate**-rate for one unit of a given quantity or thing (ex: miles per hour, miles per gallon, price per pound, dollars per hour)
Explore:
Which is the Better Buy?-students are comparing and solving ratios and proportions to determine which store item is the better buy (For example-a turkey from one brand may be $5.92 for an 8-lb turkey and another may be $8.20 for a 12-lb turkey…which is the better buy? How do you know? What would you prefer and why?)
Elaborate:
Brainingcamp activities-Ratio and Percent
Evaluate: