The Effects Of Hands-on Instructional Strategies On Fourth Grade Students' Attitudes And Performance In Mathematics

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THE EFFECTS OF HANDS-ON INSTRUCTIONAL STRATEGIES ON FOURTH GRADE STUDENTS’ ATTITUDES AND PERFORMANCE IN MATHEMATICS

by

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A thesis submitted in partial fulfillment of the requirements for the degree of Masters of Education in K-8 Mathematics and Science in the department of Teaching and Learning Principles in the College of Education at the University of Central Florida Orlando, Florida

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This thesis is dedicated to my family and friends who have encouraged me to continue even when the road became rough; to my husband, Randy who stood beside me and believed in me; to my parents who have always been and always will be my biggest supporters; to my chair, Dr. Gina Gresham who made writing this thesis easier and always had an encouraging word; to my committee for their support; to my students who made this process enlightening; to my team at Wilson Elementary School, you are unforgettable and to the wonderful LMA Cohort who made these last two years memorable and enjoyable. I could not have done this without any of you.
ABSTRACT

This study summarizes research conducted in a fourth grade classroom in a suburban elementary school in the fall of 2005. This study investigated the practice of using hands-on instructional strategies, enhanced with technology, to improve students’ attitudes and performance in mathematics. The classroom teacher supplemented conventional mathematics instruction with hands-on activities. Attitudinal data were collected using a pre- and post anxiety survey as well as journal writing assignments and student interviews. Performance data was collected using evaluative assessments. Results of this study showed a positive change in students’ attitude towards mathematics. Student performance gains were recorded and analyzed throughout the 12-week study. Twenty of the 26 students who participated in the study scored satisfactorily on all evaluative assessments. Data indicated little change was evident in student performance on assessments due to the high performing students who participated in the study.
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CHAPTER ONE: INTRODUCTION

Rationale for the Study

The words “I just don’t like math” are utterances that echo throughout classrooms at all levels for anyone who struggles with anxiety towards mathematics. Many adults bear the burden of their own mathematical shortcomings since their educational career began. Phrases like “I’m just no good at mathematics,” “I hated mathematics in school,” and “I just don’t understand mathematics” are commonly spoken among adults in social gatherings when the subject of mathematics had been raised. Few academic subjects produce as much emotional response as mathematics and research is drawing increasing amounts of attention toward the factors that play a role in the teaching and learning of mathematics (McLeod, 1994). Much of the attitudinal research in the field of mathematics has dealt exclusively with anxiety or enjoyment of the subject matter (Tapia & Marsh, 2004).

During my graduate work, I have adopted a constructivist style of teaching. In contrast to the traditional classroom, I believe that teaching and learning should be student-centered. The teacher’s role should be to develop a strong sense of community among the learners. Through her constructivist style of teaching, Marilyn Burns (1998) wrote in her book Math: Facing an American Phobia, “The way we’ve been traditionally taught mathematics has created a recurring cycle of math phobia, generation to generation, this has been difficult to break” (p. x). According The National Council of Teachers of Mathematics (NCTM, 1991), “Classrooms should be mathematics communities that thrive on conjecturing, inventing and problem solving that build mathematical confidence in students” (p. 6). In her article entitled Manipulatives: A
Hands-On Approach to Math, Barbara DeGeorge (2004) confirmed that a substantial majority of the students researched preferred hands-on projects. Student indicated that hands-on instruction helped them apply information in new situations. Many of the teachers researched also indicated significant differences in learning behaviors when students are involved in hands-on projects (DeGeorge, 2004).

A combination of the abovementioned research and my own desire to improve my teaching strategies led me to delve deeper into the effectiveness of hands-on instructional strategies and technology on students’ attitudes and performance in mathematics. As a student who once felt the pains and struggles of learning mathematics, I have empathy on the students that I witness year after year burdened with mathematics anxiety toward acquiring mathematical knowledge. I have seen students who suffer with mathematical anxiety become reluctant to take on mathematical tasks and dread learning mathematics. This reluctance seemed to have affected their academic performance and attitude negatively. Therefore, I believe the aforementioned research supports the idea that students’ mathematics anxiety can be addressed through the implementation of hands-on instructional strategies in the mathematics classroom.

**Purpose for the Study**

The purpose of this action research in which I used both qualitative and quantitative data sources was to examine the effects of using hands-on instructional strategies and technology in my mathematics teaching. By addressing students’ mathematics attitude and students’ mathematics performance, I hoped to fortify a positive attitude towards mathematics and increase students’ academic performance. More distinctively, I examined the effects of
integrating manipulatives, learning games, cooperative grouping and technology on student’s attitudes and performance in mathematics within a fourth grade classroom.

This action research study examined the effects of hands on instructional strategies and technology on student’s mathematics attitude and mathematics performance. Student’s attitudes were assessed using an attitudinal assessment survey entitled The Mathematical Anxiety Rating Scale-Elementary (MARS-E) (see Appendix A), student journals and student interviews. Student performance was assessed through evaluative assessments, student work, and teacher field notes.

Research Questions

My research was designed to answer two specific research questions:

**Question #1**

How did hands-on instructional strategies enhanced with technology affect my students’ attitudes toward mathematics?

**Question #2**

How did hands-on instructional strategies enhanced with technology affect my student’s performance in mathematics?

Definitions

Terms applicable to this research were defined as follows:

**Attitudes**: Attitudes are students’ beliefs about mathematics in the area of willingness, self-efficacy, and mathematics anxiety. Attitudes were measured using a pre- and post anxiety survey (MARS-E, 1988), student journals, student interviews, and teacher field notes.
**Cooperative Groups:** Cooperative groups are groups chosen by the students based upon whom they would like to work with in order to complete an activity.

**Constructivism:** Constructivism is active process in which learners construct new ideas or concepts based upon their current/past knowledge. Constructivism as a teaching pedagogy that is based on the theory that learning is ongoing and must be student-centered. The teacher is acting as the facilitator of the learning within the classroom community (Alkove & McCarthy, 1992).

**Evaluative assessments:** Evaluative assessments, as used in this research, were teacher made written evaluative tests for assessing skills taught in the areas of place value and money, adding and subtracting whole numbers and money, multiplication and division concepts, geometry, and fractions. These non-traditional evaluative tests were structured in a 20- question multiple choice, short answer and essay format. Performance was identified as either satisfactory at 70% or above or unsatisfactory at 69% or below.

**Hands on Instructional Strategies:** Hands on Instructional Strategies means that students utilized strategies such as cooperative groups, learning games and manipulatives as; base 10 blocks, geo-solids, fraction tiles, pattern blocks, and play money.

**MARS-E:** The Mathematics Anxiety Rating Scale-Elementary (MARS-E) is an instrument used to measure levels of anxiety towards mathematics in elementary age students. The MARS-E has been carefully developed and extensively field tested and shown reliable and valid (Suinn, 1988).

**Mathematics Anxiety:** Mathematics anxiety is a students’ feeling of fear, dread, tension, apprehension, or general discomfort that interferes with mathematics performance.
**Self-Efficacy:** Self-efficacy is a belief held by the student that they have the ability to perform a mathematical task (Townsend & Wilton, 2003). Self-efficacy is related to a student’s self-concept within the area of mathematics.

**Student Journals:** Student journals were spiral notebooks where each student would write a written response to a journal prompt posed by the researcher. Student journals were also used for students to write written reflections about the mathematics activity.

**Teacher field notes:** Teacher field notes were anecdotal records kept by the researcher. These teacher field notes were any form of written notes recorded by the teacher while observing students during activities.

**Technology:** Technology is the use of a computer, connected to the Internet, where students used the National Library of Virtual Manipulatives. Technology is also defined as a CD of learning games for each of the units during the study.

**Willingness:** Willingness is a students’ eagerness to participate in mathematics activities and functions within a mathematics classroom.

**Significance of the Study**

Students need to learn a new set of mathematics basics that enable them to compute fluently and to solve problems creatively and resourcefully (NCTM, 2000). The release of the *Curriculum and Evaluation Standards for School Mathematics* in 1989, NCTM moved to the forefront of efforts to improve mathematics education in the United States and Canada (NCTM, 2000). According to the U.S. Department of Education (2005), America’s schools are not producing the mathematics excellence required for global economic leadership and homeland
security in the 21st century. For this reason, the U.S. Department of Education (2005) declares that we “must improve achievement to maintain our economic leadership.” The design and development of the Florida Comprehensive Assessment Test (FCAT) is Florida’s effort to improve the teaching and learning standards in education. The NCLB act has required that states align K-12 assessments with their academic standards for what students should know and be able to do. In accordance with No Child Left Behind (NCLB) act, the FCAT is the state adopted academic achievement standards in the areas of reading, mathematics and science.

Recent research into student performance on the Florida Comprehensive Assessment Test (FCAT) shows that Florida students still struggle to meet state academic standards in mathematics. It is estimated that 44 percent of the students tested scored below grade level in mathematics (Associated Press, 2004). With accountability becoming increasingly important at the national and local level within the instructional area of mathematics, the Department of Education says that we must ensure that schools employ scientifically based methods with long-term records of success (2005). For the reason listed above, the use of hands-on instructional strategies and technology in the mathematics classroom helps teachers meet the representation goal of the NCTM Standards and therefore provides a means for raising FCAT scores, while addressing students’ needs.

Assumptions

From my experiences as a student and my professional experiences as a teacher, I approached this study with two assumptions. The first assumption was that integrating hands-on instructional strategies and technology into my mathematics instruction would affect my student’s mathematics attitudes. My second assumption was that integrating hands-on
instructional strategies would increase student mathematics performance. Both assumptions were based on my two research questions and a thorough review of related literature.

*Question #1*

How did hands-on instructional strategies enhanced with technology affect my students’ attitudes toward mathematics?

*Question #2*

How did hands-on instructional strategies enhanced with technology affect my students’ performance in mathematics?

Therefore, the results of this action research will bring to light the affects of additional time and resources needed to utilize hands-on instructional strategies and technology in the mathematics classroom.

**Summary**

In the following chapter, I investigated the trend of combining mathematics instruction with hands-on instructional strategies, enhanced with technology. I also examined how instructional strategies affect students’ performance in mathematics. The benefits of hands-on instructional strategies and technology on students’ anxiety as it related to their mathematics attitudes were discussed. Finally, I explored students’ self-efficacy and its effects on student’s mathematics attitudes.
CHAPTER TWO: LITERATURE REVIEW

Introduction

Student attitudes and performance in mathematics have varied. A number of students enjoy mathematics, yet many others espouse negative attitudes (Ma, 1999; Wigfield & Meece, 1988; Norwood, 1994; Extensive research supports the idea that many students suffer from anxiety toward mathematics (Ashcraft, 2002; Curtain-Phillips, 1999; Fiore, 1999; Hembree, 1990; Norwood, 1994; Stuart, 2000; and Townsend & Wilton, 2003). Mathematics anxiety has been defined as feelings of fear, tension, dread, apprehension, or general discomfort that interferes with mathematics performance (Ashcraft, 2002; Hembree, 1990, Ma, 1999, and Norwood, 1994).

According to the National Council of Teachers of Mathematics (2000), students should learn to value mathematics and become confident in their ability to do mathematics. However, mathematics anxiety has stood in the way of students becoming comfortable with their ability to perform mathematically. Anxiety towards mathematics does not appear to have a single cause. It is the result of various factors including parents’ and teachers’ attitudes towards mathematics, poor self-concept, and emphasis on learning mathematics through drill without understanding (Norwood, 1994).

In my review of the literature on students’ mathematics anxiety and attitudes and the use of hands-on instructional strategies, enhanced with technology, in the teaching of mathematics, pertinent themes emerged. These themes included mathematics instruction, student’s mathematics anxiety, as it relates attitudes, and their self-efficacy. This action research will
focus on the integration of hands-on instructional practices enhanced with technology into mathematics and the effects it has on students’ mathematics attitudes and mathematics performance. The following summary of the literature reviews the key factors involved with mathematics instruction, students’ self-efficacy and the profound influence it has on students’ mathematics attitude and performance.

**Mathematics Instruction**

Mathematics instruction was previously viewed as the teacher holding the answers and instructing the students using rote methods requiring memorization. In a study entitled, *Expanding the Scope of Mathematics Instruction*, Amy Rose (1998) indicated that the teaching of mathematics has shifted over the years. Mathematics educators are calling for a more student-centered approach (constructivism) in their teaching enabling students to construct their own meaning of math problems (NCTM, 1991).

The constructivist view on teaching and learning is that education should be student-centered, and that the teacher’s role is not to transmit information (Alkove & McCarty, 1992). Alkove and McCarty (1992) further state that constructivist classrooms are areas of discovery by the students, where they are learning mathematics by manipulating figures and forms. Moyer and Jones (2004) espouse the same idea of instruction in the mathematics classroom. “Ideally, in the 21st century mathematics classroom, control of mathematics tools and decisions to use them should be shared within a guided framework” (p.17). Thus illustrating the essentials of a constructivist classroom where the students have a say in what is learned and the manor in which it is learned.
In a study comparing constructivist and traditional Instruction, Alsup (2004) created a picture of a classroom of students grasping for pattern blocks, rulers, calculators, and even a computer to justify their solution. In turn, another picture was painted of a classroom where students were memorizing steps of a teacher-directed algorithm and practicing a litany of procedures (Alsup, 2004). The students who were given the tools to justify their solution had ownership of their answer and knew how they had derived the answer. The two classrooms vary drastically and the effect on the students’ acquisition of mathematical knowledge is considerably different.

In Alsup’s (2004) study, the group of students who were instructed under the constructivist style of instruction became less anxious about mathematics, more confident in their ability to teach it, and more empowered with regard to their own learning. In regards to instructional styles, Von Glasserfeld (1991) asserts that all too frequently the present ways of teaching mathematics generates in the student a lasting aversion against numbers, rather than an understanding of the useful and sometimes enchanting things one can do with them. When the students who participated in Alsup’s (2004) study were interviewed, many spoke positively toward constructivist teaching and learning. Many said that they preferred the constructivist instructional approach to a more traditional one because they have learned more mathematics, were more involved, and had a more pleasant experience.

Much of the mathematics anxiety present in students has roots in the teachers and teaching of mathematics (Fiore, 1999). Educators today are challenged with the choice of utilizing the most effective and beneficial method of instruction for their students. The National Council of Teachers of Mathematics, NCTM (2000) espouses that the kinds of experiences teachers provide clearly play a major role in determining the extent and quality of students’
learning. In an effort to reduce mathematics anxiety in students, researchers have evidence that supports the growing use of hands-on activities in the classroom.

**Manipulatives**

Classrooms have long come from an era of teaching where teachers would expect that all students did with their hands is fold them (DeGeorge, 2004). Traditionally teachers have relied on workbooks, drills, and memorization to present mathematical concepts (Moch, 2001). Presently teachers are exploring the use of manipulatives in the teaching of mathematics, which have been used for some time. Pestalozzi advocated the use of manipulative materials in the early 1900’s and manipulatives made their way into the classroom by the mid-1960’s (Sowell, 1989). Researchers have said that children learn better if the mathematics instruction moves from concrete to abstract (Clements, 1999; DeGeorge, 2004; Moch, 2001; and Sowell, 1989). Studies on the use of manipulatives in the classroom have shown that students who are using them outperform those who do not (Sowell, 1989).

In an article on manipulatives in mathematics, DeGeorge (2004) found that hands-on learning helps students to more readily understand concepts and boost their self-efficacy. In a meta-analysis comparing studies on manipulative material in mathematics instruction, Evelyn Sowell (1989) found that consistent use of manipulatives over a year’s period resulted in positive effects in elementary grade students.

Student achievement in mathematics has been an area of study for several years and researchers are linking the use of manipulatives to greater student achievement. In Sinan Olkun’s (2003) study comparing computer-generated manipulatives with concrete manipulatives, results showed positive effects on student’s geometric reasoning. Olkun’s research shows that fourth grade students gained more knowledge with the use of concrete manipulatives. In an
action research study entitled Manipulatives Work!, Peggy Moch (2001) found that when she utilized manipulatives within her mathematics instruction the posttest results for percentage of correct answers increased from 49 percent to 59 percent.

Alternative data were analyzed to further support her notion that manipulative use in the classroom is effective. Students demonstrated an increase in Florida Comprehensive Assessment Test (FCAT) practice tests of 4.47-13.97 percent. Moch (2003) affirms that students’ general reaction to the use of the manipulatives was encouraging as the students experienced moments of understanding while learning. Hands-on strategies such as manipulatives have been widely used in the classroom and are strongly related to student achievement (Olkun, 2003). Sowell’s (1989) meta-analysis on manipulative materials in mathematics instruction disproved older theories that manipulatives were ineffective and proved that mathematical manipulatives produced greater achievement than not using them in elementary school.

With the current pressure of standardized testing and diverse classrooms, establishing and maintaining environments where students are eager and motivated to learn continues to be a goal of the mathematics education community (Guhi & Leonard, 2002). Along with researching the outcomes of achievement related to the integration of hands on strategies such as manipulatives, recent studies have looked into the roles that are taken by teachers and students when manipulatives are used in the classroom.

In Moyer and Jones’ (2004) research on the roles of the teacher, student, and manipulatives in the mathematics classroom, they bring to light the awareness of the interactions between teachers and students in the mathematics classroom. Teachers’ roles are critical in negotiating and establishing the quality of classroom interactions (Moyer & Jones, 2004). Student’s construction of knowledge is based on their interactions and selection of mathematical
tools (Moyer & Jones, 2004). Teachers play a very strong role in the selection and control of the mathematical tools that are used in the classroom. Moyer and Jones (2004) agree that the teacher’s role is very important. However, sharing the choice is essential in establishing some control on the part of the student and their choice of manipulatives, which leads to the construction of mathematical knowledge.

Moyer and Jones (2004) advocate the use of manipulatives within mathematics instruction and the availability of those manipulatives at the student’s desks during instruction. They feel that the availability of manipulatives will give the students the opportunity to devise their own solution strategies and promote autonomous thinking and confidence in learning mathematics.

**Technology**

Due to technology, the many facets of mathematics that were once discrete take on new importance in the contemporary mathematics classroom (NCTM, 2004). Guha and Leonard (2002) advocate technology as a hands-on approach to learning. Computers help to extend mathematical ideas and in turn help to expand the minds of students (p. 42). Guha and Leonard (2002) maintain the idea that computers in the elementary mathematics classroom engage students in mathematics for longer periods and have the capability to change their attitude and performance in mathematics. According to the NCTM (2000) *Principles and Standards for School Mathematics*, technology is essential in teaching and learning mathematics; it influences the mathematics that is taught, enhancing a students’ learning.

In a study supporting the use of technology in the teaching and learning of middle grades mathematics, Guerrero, Walker and Dugdale (2004) state:
“The past two decades have seen dramatic growth in the use of technology in mathematics classrooms, diverse and appealing explorations of potential roles for that technology, and sometimes intense debates about the pros and cons of technology in teaching and learning” (p. 6).

Kersaint, Horton, Stohl, and Garofalo (2003) avow that the pervasiveness of technology in society has highlighted the need for schools to prepare students to take advantage of emergent technology tools. Barron, Kemker, Harmes, and Kaladjian (2003) assert that technological innovation is accelerating and weaving its way into our society, and that it is essential for students’ to enhance such skills as problem solving, communicating and synthesizing information via technology. The International Society for Technology in Education (ISTE) published their National Educational Technology Standards (NETS) for students claiming that the intent of technology to be an integral component or tool for learning within the context of academic subject areas. Contemporaneous with standards movement, technology is viewed as a “tool to communicate, conduct research, and solve problems” (Barron, et al 2003, p. 490).

States are taking the initiative to create technology benchmarks at each grade level and within all curriculum areas. According to the NCTM (2005), electronic technologies—calculators and computers—are essential tools for teaching, learning, and doing mathematics. NCTM (2005) further states that technology enriches the range and quality of investigations by providing a means of viewing mathematical ideas from multiple perspectives.

Many factors influence a teacher’s choice of instructional styles in their classroom. With technology being one of the most contentious and largely discussed topics, does technology have a place in the classroom and in the instruction of mathematics? Ross, Hogaboam-Gray, McDougall, and Bruce (2002) claim that research on technology use in mathematics teaching has
focused on the contribution of technology to student learning. In a recent study entitled

*Technology in Support of Middle Grade Mathematics: What Have We Learned?* Guerrero, et al. (2004) found that when technology was used well in the middle grades, it had positive effects on student’s attitudes towards mathematics. Further, technology use can have a positive impact on students learning, with significant gains in mathematical achievement and conceptual understanding (Guerrero, et al., 2004). With technology being looked on as a key component in affecting students’ attitude and performance, are educators properly trained to utilize such an instructional resource?

In a study focusing on mathematics education reform and technology, Ross, et al., (2002) assert that the impact of technology might be weaker with teachers who preferred a traditional approach to mathematics teaching and were less technologically literate. Teacher training is an imperative component of the integration of technology. Teachers, who are trained, feel more comfortable integrating technology into mathematics lessons and other subject areas. Fredrick Bennett (2002) asserts that if schools could train teachers, the argument goes; technology would finally deliver benefits to education. Teacher training is a crucial component for the successful integration of technology in the classroom. Along with training teachers to use important instructional resources such as technology, student learning is the motivation of such integration. In agreement, Ross, et al., (2002) emphasize that technology enables teachers to implement their constructivist beliefs by relieving the students of the tedium of calculation and providing them with visual representations to support dialogue about mathematical ideas.

Technology and manipulatives are being viewed as the focus of a student-centered, non-threatening mathematics classroom that provides learners with a diverse approach to learning. Teachers’ choice of activities and mathematics problems can have a strong impact on the value
that are portrayed in the classroom and on how students view mathematics and its usefulness (Wilkins & Ma, 2003). The aforementioned research supports that idea that both, technology and hands-on instructional strategies provide students with a rich environment in which they can explore, create, and justify answers.

Mathematics Anxiety

The construct of ‘mathematics anxiety’ has received considerable attention from researchers in the past few years (Newstead, 1998). Two pioneers in the study of mathematics anxiety, Richardson and Suinn (1972) defined mathematics anxiety as feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations. In the article, Anxiety and Mathematics: An Update, Tobias and Weissbord (1980) define mathematics anxiety as the panic, helplessness, paralysis, and mental disorganization that arises from some people when they are required to solve a mathematical problem.

The feeling of anxiety and tension associated with mathematics is an extensively studied and universally understood topic. In a more general definition, mathematics anxiety has been defined to be a state of emotion underpinned by qualities of fear and dread to perform mathematically (Lewis, 1970 as cited in Hembree, 1990; Ma, 1999). This feeling has gripped many students into the belief that they are unable to be successful in mathematics courses.

In Ray Hembree’s (1990) meta-analysis on mathematics anxiety, he identified two constructs that affect academics in the classroom, test anxiety and mathematics anxiety. Further Hembree (1990) concluded that even though there is a lack of individuality between test anxiety and mathematics anxiety, the construct threatens both achievement and participation in
mathematics. Although attitudes may deepen or change throughout school, once formed, negative attitudes are difficult to change and the effects are expansive. Synonymous with test anxiety, mathematics anxiety seems to be a learned condition more behavioral than cognitive in nature (Hembree, 1990). Students who are highly anxious toward mathematics tend to avoid mathematics and take fewer math courses throughout their educational career (Ashcraft, 2002).

Xin Ma’s (1999) meta-analysis on the relationship between anxiety toward mathematics and achievement in mathematics, brought to light research done by Wigfield and Meece (1998) who believe that “anxiety can take many forms; dislike, worry and fear” (p. 210). Worry has been defined as the cognitive component of anxiety, whereas the student has self-deprecating thoughts about their performance (Ma, 1999). In Shelia Tobias’s book, *Overcoming Math Anxiety*, she states, “Paranoia comes quickly on the heels of an anxiety attack” (p. 51). Students are worrying over whether or not they will be called on in mathematics class and if they are going to know the answer. They believe that everyone knows they do not know the answer and do not understand the material (Tobias, 1993).

An additional form of mathematics anxiety is fear. Fear, as defined by Wigfield and Meece (1998), is the emotionality component of anxiety. Wigfield and Meece (1988) further state that along with the feelings of fear, comes the feeling of nervousness, tension, and unpleasant physiological reactions to testing situations (Wigfield & Meece, 1998). Focusing on fear and the number of other variables associated with mathematics anxiety, a Brazilian study conducted by Utsumi and Mendes (2000) are in agreement with many other studies that, “Anxiety present on learning situations can generate an unfavorable attitude, which could result in an impediment to learning” (p. 238).
Karen Norwood (1994) has done extensive research on instructional approaches and the effects on anxiety toward mathematics. She claims that mathematics anxiety does not appear to have a particular cause. It is seen often as the result of different factors, such as inability to handle frustration, poor self-concept, parents and teachers attitudes toward mathematics, and emphasis on learning through drill without understanding (Norwood, 1994). Continuing the idea that mathematics anxiety is the result of various factors including teachers and parents, Karen Newstead (1998) espoused the idea that once anxiety is formed it is difficult to change. “Although attitudes may deepen or change throughout school, generally, once formed, negative attitudes and anxiety are difficult to change and may persist into adult life, with far reaching consequences (p. 53). Conventional wisdom and research suggest that students with negative attitudes toward mathematics have performance problems simply because of anxiety (Tapia & Marsh, 2004). The emerging theme in many studies is that mathematics anxiety has presence in students’ attitudes and the ramifications can be paramount when associated with one’s academic career.

**Self-Efficacy**

In Townsend and Wilton’s (2003) research on evaluating change in attitudes towards mathematics, they emphasize that elements of self-efficacy are present in recent calls by educators to address the problems posed by negative attitudes towards mathematics. As Seifert (2004) states in his report on *Understanding Student Motivation*, the self-efficacy theory refers to a person’s judgment about his/her capability to perform a task at a specific level of performance. This belief is formed by a history of experiences that persuade a person that he or she has what it
takes to be successful in mathematics (Townsend & Wilton, 2003). In addition, Seifert (2004) states that the worth of the individual is connected to his or her ability to do something well.

Jackson and Leffingwell (1999) found that there were three distinct age groups in which the anxiety-producing problems became evident: Grades 3 and 4, grades 9-11, and college level, predominantly in freshman year. According to their research, students became traumatized as early as kindergarten and 16% of students experienced their first traumatic encounter in grades 3 or 4. In her article entitled Teaching Math Their Way, Tankersley (1993) states that research has shown that fourth grade is often when students first experience math anxiety. Encounters such as these leave little room for the development of a student’s self-concept within the area of mathematics.

Reyes (1984) identified self-concept as the perceptions of personal ability to learn and perform tasks in mathematics. Students who are not confident perceive themselves incapable and may avoid tasks that are seen as challenging or difficult. As a result, students lack confidence in their ability to perform mathematics, thus creating mathematical anxiety (Seifert, 2004). Raising the point that students who are not confident in their skills have a lower mathematics self-concept than those who are confident.

A student’s perception on success in mathematics has been researched for years and many have found a direct relationship between a student’s self-efficacy and mathematics anxiety. Mathematics anxiety has fostered such strong research into its origin and effects on student performance. Research has concluded that mathematics anxiety can lower a students’ performance on subject specific tests such as mathematics (Hembree, 1990 and Gralinski & Stipek, 1991).
Townsend and Wilton (2003) stated that, attitudes toward mathematics appear more polarized than for any other curriculum area. They explain that certain instructional strategies may be able to increase a student’s perception of their ability to learn and therefore reduce the tension associated with mathematical tasks. With mathematics anxiety being a contributing factor to students’ dislike, fear, and poor performance in mathematics, it is important to look into instructional strategies to enhance and encourage learning taking place within mathematics classrooms.

**Summary**

The significance of teaching mathematics through hands-on instructional strategies and technology to help alleviate mathematics anxiety has been discussed. The preceding research and review of literature indicates that it is important for teachers to take a more concrete approach to mathematics instruction to have the greatest effect on students’ attitudes, sense of self-efficacy and performance in mathematics. The subsequent chapters will discuss the methodology behind the research conducted to examine fourth grade students’ mathematics attitudes and mathematics performance, discuss the positive results derived from utilizing hands-on instructional strategies and technology in mathematics, and make recommendations for future research.
CHAPTER THREE: METHODOLOGY

Introduction

As a fifth-year teacher, I have observed students with poor attitudes and performance in the area of mathematics. I conducted this study to determine the effects of hands-on instructional strategies, enhanced with technology, on students’ attitudes and performance in mathematics. The purpose of this 12-week study was to reflect on my own practice of utilizing hands-on instructional strategies and technology in mathematics to help improve students’ mathematics attitudes and mathematics performance. Quantitative and qualitative methods were used in this study. The data were collected using multiple sources. Students’ journals, student interviews, teacher field notes, a pre- and post anxiety survey (MARS-E, 1988), and evaluative assessments were used to collect data on student mathematics attitudes and mathematics performance.

Design of the Study

According to Mills (2000), action research is defined as “Any systematic inquiry conducted by teacher researchers…in the teaching/learning environment to gather information about how their particular schools operate, how they teach, and how well their students learn” (p. 5). Action research creates opportunities for all involved to improve the lives of children and to learn about the craft of teaching (Mills, 2000). The results of action research can become an important resource of effective strategies and techniques. This action research study utilized
both qualitative and quantitative methods for collecting data to investigate the following research questions:

*Question #1*

How did hands-on instructional strategies enhanced with technology affect my students’ attitudes toward mathematics?

*Question #2*

How did hands-on instructional strategies enhanced with technology affect my students’ performance in mathematics?

The qualitative data included students’ journals, student interviews, and teacher field notes. The quantitative data included a pre- and post anxiety survey entitled The Mathematical Anxiety Rating Scale-Elementary (MARS-E, 1988) written by Dr. Richard Suinn (see Appendix A) and evaluative assessments. The teacher created instruments, student journals prompts, student interview questions, and evaluative assessments, were crossed and aligned with the pre- and post attitude survey (MARS-E, 1988) to increase reliability and validity of the instruments used during the study.

Pre- and post anxiety surveys (MARS-E, 1988) were administered and used to measure changes in levels of mathematics anxiety, resulting in a change in attitudes towards mathematics. Changes were measured by comparing the mean scores from the pre- and post anxiety survey. Evaluative assessments were administered at the end of each unit and scored to show satisfactory application of knowledge gained according to the scale developed by the county in which the study took place. Evaluative assessments were tracked to show progress in students’ mathematics performance throughout the research period.
Assumptions

This study was approached with the assumption that, by combining hands-on instructional strategies enhanced with technology in mathematics, students’ mathematics attitudes and performance would improve. This assumption was based on a thorough review of related literature and my own professional teaching experience. It was also assumed that students did their best on every written response and evaluative assessment assigned during the research period. The triangulation of the data sources were used to decrease teacher bias. I did not want to influence my students’ responses.

Setting

School Setting

This study took place in an elementary school located in a suburban area of Central Florida. The elementary school provided services for students from kindergarten to fifth grade. This school has received many noteworthy accomplishments including: Florida Department Of Education 'A' School Designation, 2004-2005; Federal Adequate Yearly Progress Designation, 2004-2005; Golden School Award, 2004-2005; and International Center for Educational Leadership Model School. According to the November 2005 Membership, the school has 1046 students, of which 541 are female and 505 are male. Ethnically, the school is comprised of 554 white, 244 black, 37 Asian, 157 Hispanic, 3 American Indian, and 51 multiracial students. A portion of the school, 33% or 345 students, is on free and reduced lunch, considered economically disadvantaged.
Classroom Setting

The study was conducted in a self-contained, co-teaching model, fourth grade classroom consisting of 32 students. In addition to mathematics instruction, I taught the students science and my co-teacher taught language arts and reading throughout the course of the school day. The mathematics instruction took place at the beginning of the school day and lasted between sixty to seventy-five minutes each day for 12 weeks.

Curriculum covered during the research period were place value and money, adding and subtracting whole numbers and money, multiplication and division concepts, geometry, and fractions. Place value and money was taught for 3 weeks, adding and subtracting whole numbers and money was taught for 2 weeks, multiplication and division concepts were taught for 1 week, geometry was taught for 3 weeks, and fractions were taught for 3 weeks. Each of the time frames for the topics covered are approximations dependent on how the unit came to together.

Of the 32 students assigned to this class, eight students were gifted and two were learning disabled. The learning-disabled students received mathematics instructions from a special needs teacher and did not participate in the study. One student failed to return the Parental Consent Letter and three students enrolled after the study had begun. Those three students did not participate in the study. Therefore, of the 32 students enrolled in my class, 26 participated in the study from beginning to end. Eleven of the 26 students who participated in the study were male, and fifteen were female. The research group consisted of one Asian child, four black children, four Hispanic children, and seventeen Caucasian children.
Data Collection

Prior to beginning the study, permission was sought and obtained from the University of Central Florida Institutional Review Board (IRB) (see Appendix B). Approval was obtained from the school principal (see Appendix D) and parental consent was obtained for each of the participating students (see Appendix E). I explained my requirements and provided an opportunity for students to ask questions. Once I received permission from the parents and the students gave their assent, I preceded with the study. In order to respect student confidentiality, their names were not used and student numbers were assigned.

Lessons and activities for this study followed the same format during each mathematics class period. Cooperative groups were student-selected groups and they were established prior to beginning the lesson or activity. Students were then presented with a problem to solve or with a situation based on the curriculum and they were asked to figure out the answer. Dependent on the lesson, manipulatives (Base 10 blocks, Geo-solids, Fraction tiles, Pattern Blocks, and play money) and technology (virtual manipulatives) were used to facilitate the most effective learning environment. Once the problem had been solved, the lesson or activity continued by delving deeper into the topic. Discoveries were being made and questions were answered as the students solved problems and created similar problems for either their group or the class to solve.

Teacher field notes were taken throughout the study noting student conversations and behaviors as they interacted with one another. If they were working independently, their progress was noted along with questions that they asked while working. Once the lesson or activity had been completed, student were then directed to take out their Math Journals and respond to a journal prompt written to elicit their reactions and opinions to the lesson or activity that utilized the hands-on instructional strategies, enhanced with technology.
Student interviews were conducted at the beginning, middle and end of the research period. When students were being interviewed, I was looking for key words used in their responses and behavior exhibited while each student was interviewed. Some examples of key words were; liked, fun, exciting, loved, and neat.

Once a unit within the curriculum had been covered, an evaluative assessment was administered during the mathematics class period. Evaluative assessments were 20-item assessments that were situated in a multiple-choice, short answer, and essay format. Students were given unlimited time to complete the evaluative assessment. Evaluative assessments were graded on a 100-point scale. Students that scored a 70 percent or higher received a satisfactory score and students that scored a 69 percent or less received an unsatisfactory score.

The qualitative data collection for this action research included students’ journal entries, student interviews, and teacher field notes. The quantitative data collection was a pre- and post anxiety survey (MARS-E, 1988) (see Appendix A) and evaluative assessments. The instruments used to measure students’ attitudes and academic performance in mathematics were discussed in the subsequent sections.

**Instruments**

**Student Journals**

Each student had a designated notebook specifically used for journal writing sessions. Every notebook was labeled “Math Journal.” The purpose of the student journal was to help me identify and monitor students’ attitudes through journal writing prompts. Journals prompts were posed after each mathematics lesson and students were asked to give written responses for each journal prompt (see Appendix H) in addition to reflecting on the lesson. Journals were collected and reviewed after each lesson or activity and then returned to the student prior to the next lesson.
or activity. These journal prompts were completed to monitor students’ changing attitudes towards mathematics. Written responses to journal prompts were used to direct and guide student interviews, which also served as a source of data collection.

**Student Interviews**

Student interviews were held three times throughout the research period to inquire further from students their attitude toward mathematics. Teacher posed a series of questions (see Appendix F) to the student, while the student verbally responded. Each student had the same set of questions for the interview. Interview questions were derived from a variety of sources. One question was taken from the pre-anxiety survey (MARS-E, 1988), two questions were created from the research questions and the last two questions I created. In creating these last two questions, I was looking to further understand students’ opinions and feelings about using hands-on instructional strategies, enhanced with technology. Creating interview questions from the pre- and post anxiety survey and the research questions, I was able to further validate the data source. Students’ responses to interview questions were also recorded as teacher field notes, which were used as an additional data source.

**Teacher Field Notes**

Teacher field notes were taken during each lesson or activity and used as a data source throughout the study. During the research period, I observed students’ interaction with others during cooperative group activities and independent assignments and recorded this information in a notebook. Supplementary teacher field notes included students’ questions toward activities, responses to cooperative group activities, independent activities, and general statements made in regards to mathematics throughout the research period. This form of data collection provided
information needed to assess on-going students’ attitudes. Teacher field notes were used to further triangulate students’ mathematics attitudes.

**Pre- and Post Anxiety Survey**

The pre- and post anxiety survey was obtained from Dr. Richard Suinn (1988). The reliability of this survey is shown to have a high intercorrelation of the items, which confirms the high reliability of the survey (Suinn, 1988). Students completed the pre- and post anxiety survey (MARS-E, 1988) specifically designed for elementary students, at the beginning of the research period (see Appendix A). The anxiety survey was obtained and administered according to the recommendations of the author, Dr. Richard Suinn (1988). Students were given the 26-item pre- and post survey (MARS-E, 1988) to determine their levels of mathematics anxiety. To ensure that the students were being tested on their mathematics anxiety and not their reading ability, each inventory item was read aloud and time was allotted for each student to designate a response. It took approximately 35 minutes to administer the pre- and post anxiety survey. The participants’ mean scores were arranged on a spreadsheet using Microsoft Excel. The data were used to further triangulate data collected throughout the study, measuring students’ mathematics attitudes.

**Evaluative assessments**

Students completed the written Evaluative assessments after each unit or chapter covered during the research period. Evaluative assessments were teacher created 20-item instruments used to measure skills learned during hands-on instructional activities enhanced with technology. The evaluative assessments were a combination of multiple choice, short answer, and essay questions. There were five evaluative assessments administered throughout the research period: 1.) Place Value and Money, 2.) Adding and Subtracting Whole Numbers and Money, 3.)
Multiplication and Division Concepts, 4.) Geometry, and 5.) Fractions. Each student was given the opportunity to select an answer for the multiple-choice questions on the evaluative assessment. The short answer and essay questions provided an opportunity for the students to solve and justify their answers, illustrating application of knowledge. This method of data collection was used to measure students’ performance following a specific unit or chapter that had been taught using hands-on instructional strategies enhanced with technology.

Credibility/Trustworthiness

To increase trustworthiness and credibility of the study, data results were triangulated across research methods. The triangulation of data included: students’ journals, student interviews, teacher field notes, pre- and post anxiety survey (MARS-E, 1988), and evaluative assessments. The themes presented resulted from a triangulation across methods aligned with research questions.

Data Analysis Procedures

Student Journals

Students were asked to respond to various journal prompts (see Appendix H) following an activity that utilized manipulatives, games, cooperative learning and/or technology. First, I placed the journal prompts on the overhead projector and read aloud the prompts. Next, I offered an opportunity for questions. After reading the problem aloud, I provided time so that student could complete the journal prompt independently. Journal prompts were written to elicit a reaction about their experience with the instructional approach and the student’s perception of their success throughout the activity. For example, “I liked using the Geometric Solids during
the lesson today.” “Today’s lesson was fun because I could use the Base 10 Blocks to regroup.”

Student journals were collected and reviewed after each session. When analyzing students’ journals I was looking for descriptive words like: enjoyed, liked, fun, exciting, neat, and cool.

Journals were read and tallies were kept to track the number of students feeling positive or negative about the lesson and their ability to learn mathematics utilizing hands-on instructional strategies. Journals were also noted for changes in attitudes and compared to the pre- and post anxiety survey. The combination of pre anxiety survey results, teacher field notes and journals were used to plan for subsequent lessons and activities. Students’ journals were returned to them before the next lesson. A sampling of journal prompts is provided in Appendix H.

Student Interviews

Students were interviewed three times throughout the research period to better understand students’ attitudes towards mathematics. Students were chosen based upon their reactions towards activities recorded in their student journals, teacher field notes, and results from the pre anxiety survey. The objective of the student interviews was to better understand students past experiences in mathematics, perceptions about their ability to be successful in mathematics, and their view on mathematics utilizing a hands-on instructional approach enhanced with technology.

When interviewing students, I looked for descriptive words or phrases. Some examples are as follows: fun, exciting, cool, I liked today’s lesson, today’s lesson helped me, and I understood the lesson. When students use these types of positive descriptive words, I noted the fact that the lesson had a positive effect on the student. Some examples of negative responses are: I did not understand, I did not like today’s lesson, and math is really hard for me. A student responding in such a way was noted as a negative response. As a part of my data analysis, I keep
a tally of how many students responded to the questions in either a positive or a negative way. Occasionally, new questions were asked during student interviews to fully understand students’ responses to interview questions.

Throughout the study, student interviews were triangulated with responses to journal prompts, reactions to activities recorded in teacher field notes, and the results from the pre- and post anxiety survey (MARS-E, 1988). The triangulations of these data pieces were used to measure a change in attitude and keep with the credibility and trustworthiness of this study. A complete sampling of interview questions is provided in Appendix G.

**Teacher Field Notes**

As a part of my routine, I recorded student’s interactions and comments made during activities and lessons. As the students worked either cooperatively or independently, I made notes about their comments, distinctive solutions, realizations, and overall attitude toward the activity. I continued to take field notes as I interviewed the students looking for parallels between their responses and level of participation during an activity.

When analyzing my teacher field notes, I was looking for positive or negative descriptive words or phrases. Some examples are as follows: liked, did not like, enjoyed, did not enjoy, I understood, and I did not understand. These positive or negative responses were recorded and triangulated with the student’s responses to journal prompts and interview questions to track attitude changes, whether positive or negative. This combination of teacher field notes, in conjunction with student responses to journal prompts, responses to interview questions and pre- and post anxiety survey results, were used to assess students’ attitudes on a continuous basis and direct lessons for future implementation.
Pre- and Post Anxiety survey

The 26-item pre- and post anxiety survey (MARS-E, 1988) was written to assess student’s level of mathematics anxiety. Items on the anxiety survey were written for varied responses ranging from “not at all nervous” to “very nervous.” Students’ responses were analyzed using an Excel spreadsheet. When a student responded “not at all nervous” to a written question or statement, a “1” was recorded. When a student responded “not very nervous” to a written question or statement, a “2” was recorded. From there, when a student responded “fairly nervous” a “3” was recorded, “very nervous” was recorded as a “4” and “very, very nervous” was recorded as a “5.” Mean scores were generated by multiplying the number of checks by the corresponding weights for each response. To find the total score, responses on each page were multiplied by the corresponding weight. The total for each page was recorded at the bottom. The sum of all the products on each page provides the total score for the test.

According to the MARS-E (1988) Survey, fourth grade students who score a 43 are in the 10th percentile expressing low mathematical anxiety. Students scoring a 47 are in the 30th percentile, expressing medium to low mathematical anxiety. Students who score a 52 are in the 50th percentile having a medium level of mathematical anxiety. Students who score a 63 are in the 75th percentile having a medium to high level of mathematical anxiety. Lastly, students who score an 85 are in the 95th percentile having a high level of mathematical anxiety.

The responses for the pre- and post anxiety survey (MARS-E) were compared to determine if a change had occurred in the students’ level of mathematics anxiety after participating in lessons that used cooperative groups, games, manipulatives, and technology. Data were triangulated with student journals, student interviews and teacher field notes.
Evaluative assessments

Evaluative assessments were given to each of the students participating in the study at the end of a unit or chapter. Each of the five 20-item evaluative assessments were weighted the same and the total points for the assessment were 100. Evaluative assessments were a mixed format of multiple-choice, short answer, and essay. Students were able to select an answer for the multiple-choice section of the assessment. For the short answer and essay sections of the assessment, the students needed to provide a solution to the question and justify their solution.

To run parallel with the grading scale within the county the study took place, a score of a 70% or greater was scored as satisfactory. A score of a 69% or less was scored as unsatisfactory. Evaluative assessment scores were recorded on an Excel spreadsheet throughout the study. Students’ evaluative assessment scores were tracked for a change in performance level. Evaluative assessment scores were also triangulated with the pre- and post anxiety survey (MARS-E, 1988), students’ journals, student interviews, and teacher field notes, to align the students’ changes in attitude and the changes in performance.

Summary

Data from all sources: students’ journals, student interviews, teacher field notes, pre- and post survey (MARS-E, 1988) and evaluative assessments were recorded, triangulated, and analyzed to show the effects of hands on instructional strategies enhanced with technology on students’ mathematics attitudes and mathematics performance. Data were collected and analyzed to identify changes in levels of anxiety, changes in attitude, and performance. Chapter four discussed the positive effects of utilizing hands-on instructional strategies enhanced with technology in a fourth grade classroom and chapter five gave recommendations for further research.
CHAPTER FOUR: DATA ANALYSIS

Introduction

This action research study investigated students’ attitudes and performance in a fourth grade mathematics classroom. An action research design was selected because it creates opportunities, via personal reflection and data analysis, to improve the educational experience of students (Mills, 2003). My interest in this topic developed over the years as I struggled through mathematics as a student. As a teacher, I continue to encounter many students who struggle with the same mathematics anxiety. This chapter discussed the effects hand-on instructional strategies, enhanced with technology, had on elementary students’ attitudes and performance in mathematics.

Data collection methods for this study were students’ journals, student interviews, teacher field notes, pre- and post survey (MARS-E, 1988), and evaluative assessments. Using multiple data resources allowed for triangulation of data across research methods. The research questions for this study were:

Question #1

How did hands-on instructional strategies enhanced with technology affect my students’ attitudes toward mathematics?

Question #2

How did hands-on instructional strategies enhanced with technology affect my students’ performance in mathematics?
Table 1: Research Questions and Triangulations

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Data were collected from three different sources that related to students’ attitude and performance in order to correlate the subsequent findings. Data were analyzed from pre- and post anxiety surveys, students’ journals, student interviews, and teacher field notes. As I began to analyze data from the pre- and post anxiety survey (MARS-E, 1988), read the student’s journal entries, notes from interviews and teacher field notes, several pertinent themes emerged from the data. One theme that emerged in the study was that hands on instructional strategies enhanced with technology, decreased students’ anxiety toward mathematics. Data from the MARS-E (1988) showed that 69% (18 out of 26) of the students’ anxiety decreased from the pre-test to the post-test. Another theme that emerged included improved student attitude toward mathematics when using hands-on instructional strategies enhanced with technology. When teacher field notes were analyzed, student behavior illustrated the fact that they were more inclined to participate in lessons and activities that were combined with cooperative grouping, manipulatives, games and technology. Triangulation between student interviews and students’ journals also support the idea that students attitudes improved during this study. A final theme that emerged was that hands-on instructional strategies enhanced with technology had minimal effect on student academic performance in mathematics. Although the students’ anxiety had
been decreased and their attitudes were improving, student’s performance showed little change in their overall application of mathematics skills learned during the study. Students maintained a high level of performance and the use of hands-on instructional strategies did not prove to have negative effects on the students’ performance during the study.

At the beginning and completion of the research, students completed the pre- and post anxiety survey (MARS-E, 1988) that provided data on their mathematics anxiety and attitude. Students also wrote in their mathematics journals and participated in one-on-one interviews with the researcher to gather attitudinal data. Teacher field notes were also used in the triangulation of attitudinal data. Evaluative assessments completed the data collection process. The following section presented an overview of a typical mathematics class period and the data analysis aligned according to research questions.

A Typical Mathematics Class

A typical mathematics class involved students working in cooperative groups or independently utilizing manipulatives, games and technology in support of the curriculum taught. At the beginning of the study, my focus was on place value and money along with adding and subtracting whole numbers and money. For these two units I utilized base ten blocks and play money as the manipulatives. I also incorporated teacher made games. The third unit of the study focused on multiplication and division concepts where I used teacher made games, base ten blocks, and CD of multiplication and division games. The next unit was on Geometry. For this unit I used the National Library of Virtual Manipulatives on the Internet, geometric solids, pattern blocks and teacher made games. The last unit of this study focused on fractions. For this unit I used fraction tiles, CD of fraction games and teacher made games.
Lessons or activities used during the study, students were able to use manipulatives, games, and/or technology to support the lesson. Mathematics lessons and activities began with engaging the students using a question or presenting them with a problem to solve. The hands-on instructional strategies, whether manipulatives, cooperative groups, games, or technology, were explained to the students prior to beginning the activity. Mathematics lessons and activities used one or more of the hands-on instructional strategies to support the knowledge being constructed by the students. Following the lesson or activity, students were instructed to respond to a journal prompt in their math journals. At the end of each of the five units or chapters presented throughout the research study, students were given an evaluative assessment to gauge the effectiveness of the hands-on instructional strategies.

These fourth grade students had very little previous experience using hands-on instructional strategies in the mathematics classroom, according to the students and parents. In these intermediate elementary grades, mathematics lessons are typically taught by showing a few examples of how to solve a problem and then the students will practice a litany of problems. Responses from the students were that this was the first time many of them had experienced working with hands-on instructional strategies and I was particularly interested in the student’s initial levels of attitudes, as it relates to anxiety, and the change in their attitudes as the study progressed.
Student Anxiety

Research Question #1: How did hands-on instructional strategies affect my students’ attitudes toward mathematics?

To fully understand the students’ level of anxiety toward mathematics, the MARS-E (1988) pre-survey was used to determine their actual level of mathematics anxiety. The pre- and post anxiety test was administered to the twenty-six students at the beginning of the research period and once again at the end. The 26-item pre- and post anxiety survey (MARS-E, 1988) was written to assess students’ mathematics anxiety. Items on the anxiety survey were written for varied responses ranging from “not at all nervous” to “very nervous.” Students’ responses were recorded on an Excel spreadsheet.

The MARS-E (1988) was used as an instrument to measure students’ levels of mathematics anxiety prior to beginning mathematics instruction. Once the pre anxiety survey was administered and scored, I began my mathematics instruction utilizing hands-on instructional strategies, enhanced with technology. As the study continued, I referenced students’ percentile level of mathematics anxiety and connected that to their journal responses, interview responses, and my teacher field notes. Drawing these connections illustrated the presence, or absence of mathematics anxiety in students’ attitudes towards mathematics. The same instrument, MARS-E (1988) was administered again at the end of the study to measure a change in students’ mathematics attitudes. The data collected from the post anxiety survey was triangulated with the students’ pre anxiety survey results, student journals, student interviews, and teacher field notes to note any changes in students’ levels of mathematics anxiety.
Pre-Survey Results

On the pre-survey, 15% (four) of the students surveyed, scored within the 10th percentile, 31% (nine) of the students surveyed scored in the 30th percentile, 23% (six) of the students surveyed scored in the 50th percentile, 23% (six) of the students surveyed scored in the 75th percentile, and 4% (one) of the students surveyed scored in the 95th percentile. The following figure represents the scores from the pre anxiety survey.

![Graph showing pre-survey results]

Figure 1: Pre Anxiety Survey Results

Analysis of student journals and teacher field notes, at the beginning of the study, indicated that Student 2 and 26 were very reluctant to participate in lessons and activities. Student 2 commented several times throughout the study, “I cannot understand math and I don’t know how to do it [math].” During cooperative group activities, Students 2 and 26 would listen as the other group members offer suggestions to solve the problem or complete the task. In contrast, students 6, 7, 8, 18, and 25 scored in the 75th percentile, a medium to high level of mathematics anxiety. These students, according to their journals and teacher field notes, were
actively involved in lessons and activities. In review of the students’ interviews, these five students all responded to the question, “Do you like math?” positively.

Analyses of the evaluative assessments indicate that student 2, 6, and 25 satisfactorily passed all assessments, with the exception of the one. Students 7, 8, and 18 passed all evaluative assessment satisfactorily. On the contrary, student 26 had a more difficult time passing the evaluative assessments. Student 26 only passed evaluative assessment 2, Adding and Subtracting Whole Numbers and Money and evaluative assessment 3, Multiplication and Division Concepts.

Post-Survey Results

At the conclusion of the study, the same survey was re-administered, to measure a change in students’ mathematics anxiety levels as a result of using hands on instructional strategies, enhanced with technology, in mathematics instruction. On the post-survey, 31% (eight) of the students surveyed, scored within the 10th percentile, 15% (4) of the students surveyed scored in the 30th percentile, 27% (seven) of the students surveyed scored in the 50th percentile, 23% (six) of the students surveyed scored in the 75th percentile, and 4% (one) of the students surveyed scored in the 95th percentile. The following table represents the scores from the post-anxiety survey.
Pre- and Post Survey Analysis

The purpose of the pre- and post anxiety survey, used within this study, was to measure changes in students’ mathematics anxiety based on the use of hands on instructional strategies in mathematics instruction. The pre anxiety survey was administered at the beginning of the study, hands-on instructional strategies, enhanced with technology, were combined with my mathematics instruction for 12 weeks and the post anxiety survey was administered once more at the end of the study to measure a change in students’ mathematics anxiety. Of the students surveyed, 18 out of 26 (69%) showed a decrease in score resulting in a lower level of mathematics anxiety. The remaining nine students showed an increased score resulting in a higher level of mathematical anxiety.

Based upon the MARS-E (1988) survey results, either students moved from one percentile level to another or their score remained within a specific percentile level indicating a change in score, but not a change in their level of mathematical anxiety. Of the 26 students surveyed, ten student’s percentile levels of anxiety did not change. Although those ten student’s percentile levels did not change, eight of those ten students’ scores decreased (Students 2, 3, 11,
17, 19, 21, 23, 24) and one student’s score increased (Students 10), indicating that their percentile level of mathematical anxiety remained the same. The remaining 16 students either increased or decreased in their level of mathematical anxiety.

Of the remaining 16 students, seven of their scores increased and nine of students showed a decrease in their level of mathematical anxiety. The students who showed an increase either moved one or two percentile levels. Student 4 moved from the 10\textsuperscript{th} percentile to the 50\textsuperscript{th} percentile. Students 5, 15 and 22 moved from the 30\textsuperscript{th} percentile to the 75\textsuperscript{th} percentile. Students 12, 13 and 14 moved from the 50\textsuperscript{th} percentile to the 75 percentile.

Analysis of student journals and teacher field notes, when looking for descriptive words and positive or negative behaviors, indicate the students 4, 12, 14, and 22 participated during mathematics lessons and activities, but made several statements that it took them longer to understand mathematics concepts than others. These students often paired themselves up with higher performing students and often had to get caught up with the other students during cooperative group activities. Evaluative assessments from these students indicate that they were able to successfully construct the knowledge and apply it in an assessment situation.

Student interviews from students 5, 13, and 15 indicate that they enjoyed mathematics, but a different attitude emerged when asked interview question #4, “Do you feel you are better able to understand math as a result of using hands-on instructional strategies (manipulatives, games, cooperative groups, and technology)?” Student 13 said, “I like using the games and manipulatives, but it just takes me too long to understand math.” Students 5 and 15 agreed that they have a hard time understanding mathematics.

The students whose levels decreased also showed movement of either one of two percentile levels. Students 1, 20, and 16 moved from the 30\textsuperscript{th} percentile to the 10\textsuperscript{th} percentile.
Student 6, 8, 18 also moved one-percentile level, from the 75th to the 50th. Students 7, 9, and 26 showed the greatest decrease in their level of mathematical anxiety. Students 7 and 26 moved from the 75th percentile to the 30th and student 9 moved from the 50th to the 10th percentile. The results of the pre-post anxiety survey are summarized in Figure 3.

![Pre- and Post Anxiety Survey Results](image)

Figure 3: Pre- and Post Anxiety Survey Results

These data, student journals, student interviews, teacher field notes, and pre- and post anxiety survey indicate that most students surveyed have moderate levels of mathematics anxiety. Analysis of the pre- and post anxiety survey illustrated that, of the 26 students surveyed, 30% (8 out of 26) of the students’ mathematics anxiety increased, while 69% (18 out of 26) of them had a decrease in their mathematics anxiety based on the results from the MARS-E (1988) anxiety survey. The theme that emerged from the results of the pre- and post anxiety surveys, triangulated with the data sources listed above, when hands-on instructional strategies,
enhanced with technology, are combined with mathematics instruction in the classroom, students’ mathematics anxiety can be decreased.

**Student Attitude**

To analyze students’ mathematics attitudes when combining mathematics instruction with hands on instructional strategies enhanced with technology, I examined students’ journal entries, student interviews, and teacher field notes. Analysis of the data sources meant looking for parallels between what the students were saying when working in their groups and how they were responding to interview questions. More specifically, I was looking for positive words or phrases spoken by the students. Such as, I like this activity, this is fun, I know how to do that, or I do not understand, I hate math, and this is boring.

Students were interviewed at the beginning, middle and end of the study. When students were asked question #1, “Do you like mathematics,” 42% (11 of the 26) of the students responded yes to that question. After probing students further as to why some do not like math they responded to the manor in which mathematics was taught in the year prior to this one. Some students’ responses are as follows:

- Math is all bookwork.
- I did not understand math cause (sic) it was too hard and the teachers went too fast.
- I do not like math because it is not very interesting.
- Math is boring. All you do is solve problems. It’s not fun.

At the conclusion of the study, students were asked question #1, again and 92% (24 out of 26) students said that they liked mathematics. Student 11 said, “Yes, I do like math. It [math] has always been easy for me.” In contrast, Student 10 commented, “I like math, but you
have to solve really hard problems.” Student 8 agreed, “Math is okay. The work is hard and I don’t understand it most times.” Some student’s responses were mixed.

Students were then asked in Interview Question #4, “Do you feel you are better able to understand math as a result of using hands-on instructional strategies (manipulatives, games, cooperative groups)?” Student 1 responded, “Yes, it is more helpful to have other people to help you understand.” Student 18 agreed, “I like using games and manipulatives to learn math. You have your friends there to help you and you can use things to help you find out the answer.” When asked, 96% (25 out of 26) of the students responded positively that they were better able to understand mathematics as a result of using hands-on instructional strategies. In contrast, 4% (1 out of 26) responded that using hands-on instructional strategies did not help them to understand mathematics. Some of the responses were as follows:

- Yes, I feel like I really understand more math then before.
- Working in groups helped me to understand math better because working in groups I can ask someone a question if I don’t understand.
- It (hands-on instructional strategies) has kinda (sic) helped me, but I still don’t really understand math.
- I understand math more because of using manipulatives, playing games, and working in centers. I think I understand it more because it is more fun.

The responses to the student interviews provided me with insight as to whether or not students liked math. Moreover, students’ responses helped me to see that many of the students who responded negatively toward the interview questions were the students who have high mathematics anxiety based upon the MARS-E (1988) anxiety survey. This confirms what was stated in Ma’s (1999) meta-analysis on mathematical anxiety and achievement in mathematics. According to Ma (1999), mathematics anxiety is usually associated with mathematics achievement individually but not collectively.
Throughout the course of this study, hands-on instructional strategies, enhanced with technology, were combined with lessons that focused on five distinct areas of mathematics; Place Value and Money, Adding and Subtracting Whole Numbers and Money, Multiplication and Division Concepts, Geometry, and Fractions. These activities were paralleled to the district adopted standards and the Sunshine State Standards. When cooperative groups were used, students selected their own group in order to complete the activity. Teacher field notes, student journals, and student interviews were utilized in order to capture the essence of the students’ attitudes towards learning mathematics through hands-on instruction strategies enhanced with technology.

After one of the first cooperative group activities, which focused on place value of whole numbers utilizing base ten blocks, students were asked to respond in their journals to the following question, “How did you feel about using hands-on instructional strategies (manipulatives, games, and cooperative groups) in mathematics? Sixty-five percent (17 out of 26) of the students responded positively to using hands-on instructional strategies in mathematics. In review of the teacher field notes taken at the beginning of the study, those nine students were hesitant to adjust to this change in instructional style. When asked why she felt this way, student 10 said, “Why don’t you just show us how to do it. That’s the way I’m used to learning math.” Following that conversation, student 10 remained reluctant to adjust to the new mathematics instructional strategies.

In contrast, at the conclusion of the study, all of the students (100%) responded positively in favor of using hands-on instructional strategies in mathematics, along with student 10. When student 10 was asked if she liked using hands-on instructional strategies in mathematics, she was
in favor. “Math is still tough, but these games and manipulatives are fun to use and I think that I’m learning more.” Some of the responses were as follows:

- I like using the manipulatives to learn math cause (sic) it was more fun.
- Playing games in math made it more fun and easier to learn,
- I feel more comfortable with fractions cause (sic) I used the fraction tiles. I know them better.
- Using games, working in groups, and all that fraction stuff (manipulatives) made math more fun.

Analysis of student interviews, journal prompts and teacher field notes illustrated the fact that students mathematics attitudes had improved and students gained more confidence in their ability to perform mathematical tasks. An example of changing student attitude while using hands-on instructional strategies was a lesson that was focused around the utilization of fraction tiles to explore fractional concepts. During cooperative group time, students were asked, “Did the fraction tiles help you to understand fractions on a number line?” Student 6 responded, “The fraction tiles helped me to understand the lesson because they helped me to visualize the fractions.” Many students responded with similar answers, while some students referred to how much they enjoyed the activity. The following statements represent a sample of responses:

- “Fraction tiles did help me because I am a visual person and I need to see it to understand it.”
- “Kind of yes beause (because) it hleped (helped) me make the number line and hleped (helped) me find the equivilante (equivalent).”
- “Yes, the fraction tiles helped me understand the lesson because I think it is funner (sic) to use fraction tiles instide (instead) of not useing (using) it.
- “One thing that I learned was that a fraction can be equal to a different fraction.”
- “Yes they did help me to understand way better and they were fun.”

The responses for many of the students’ journal prompts relating to the use of the fraction tiles indicated to me that many of the students connected to using the fraction tiles. For example, student 3 responded to the journal prompt, “How did you feel about today’s math lesson?” She
responded, “I enjoyed everything because it was fun and you were learning at the same time.”

Student 12 said, “I never knew fractions could be this fun.  I feel good about learning fractions.”

Reflections from student interviews and teacher field notes also illustrated the fact that students enjoyed being able to manipulate the fraction tiles. Students quickly asked to use the fraction tiles again in subsequent lessons. Dialogue between students illustrates the notion that students mathematics attitudes are improving and they are more apt to use hands-on instructional strategies to learn mathematical concepts.

Students’ journals, student interviews, and teacher field notes were analyzed to measure changes in students’ mathematics attitude while combining mathematics instruction using hands-on instructional strategies, enhanced with technology. Students’ interview responses to question #4 and question #5 indicated that students’ mathematics attitude had improved. Students said that they enjoyed learning mathematics using hands-on instructional strategies, enhanced with technology because working in groups was fun and helpful, while using manipulatives and games made the mathematics easier.

Further analysis of the attitudinal data showed that student 2 continued to struggle with mathematics. When asked interview question #4 during the post-interview, she responded negatively, saying that she still did not understand mathematics. Post anxiety survey (MARS-E, 1988) also showed student 2 as having an unchanged anxiety percentile level of 94. Even though this student’s level fell 8 points, she was still exhibiting a high level of mathematical anxiety, resulting in the belief that student 2 did not understand mathematics more using hands-on instructional strategies. This is an indicator that combining mathematics instruction with hands-on instructional strategies, enhanced with technology, improved students’ mathematics attitudes.
Students’ Performance

Research Question #2: How did hands-on instructional strategies enhanced with technology affect my students’ performance in mathematics?

Data on students’ performance were collected from evaluative assessments. Student journals were collected and analyzed throughout the study period to make a connection between levels of performance and attitudes toward mathematics. Evaluative assessments were given at the end of each unit or chapter and students were made available the use of manipulatives during the evaluative assessments. Teacher field notes were taken while students completed activities, lessons, and evaluative assessments, to further triangulate the attitudinal data with performance data.

These data were broken down into five sections throughout the course of the 12-week study and analyzed. Evaluative Assessment #1 was Place Value and Money. Evaluative Assessment #2 was Adding and Subtracting Whole Numbers and Money. Evaluative Assessment #3 was Multiplication and Division Concepts. Evaluative Assessment #4 was Geometry and Evaluative Assessment #5 was Fractions. Satisfactory performance was indicated by a student scoring a 70 percent or above. An unsatisfactory performance was indicated by a 69 percent or below. Each evaluative assessment was scored out of one hundred points and scores were recorded on an Excel spreadsheet. Student performance was then compared to journal responses, teacher field notes, and the pre- and post attitude (MARS-E, 1988) survey to analyze change in performance. Table 2 represents the student performance scores for assessment all five assessments.
### Table 2: Evaluative Assessment Summary

<table>
<thead>
<tr>
<th>Evaluative Assessments</th>
<th>Number of students scoring satisfactorily</th>
<th>Percent of the class</th>
<th>Number of students scoring unsatisfactorily</th>
<th>Percent of the class</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>24</td>
<td>92%</td>
<td>2</td>
<td>8%</td>
</tr>
<tr>
<td>2</td>
<td>22</td>
<td>85%</td>
<td>4</td>
<td>15%</td>
</tr>
<tr>
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<tr>
<td>4</td>
<td>24</td>
<td>92%</td>
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<td>8%</td>
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<tr>
<td>5</td>
<td>25</td>
<td>96%</td>
<td>1</td>
<td>4%</td>
</tr>
</tbody>
</table>

**Evaluative Assessment #1**

During the first few weeks of the study, we were working on place value concepts, utilizing base 10 blocks, and teacher created games. Observations made in my teacher field notes indicate a class of students who are reluctant to perform mathematical tasks in front of their peers. During a lesson where we were building numbers using base 10 blocks, students were working in pairs to solve the following problem. I wrote the number 1,400 on the board. “Show this number using the fewest amount of blocks. Now show this number using the most blocks.” Students were very quiet and did little talking to their partner during the activity. Lack of conversations indicated to me that the students were not used to working with another person to solve mathematical problems.

The lesson continued and I placed more numbers on the board asking students to describe the number in two different ways. Student 17 commented, “These numbers are really the same it is just showing how you can trade blocks in for another piece. The names are different, but the values are the same.” Student 13 was amazed, “They are worth the same!” Student 25 questioned whether they were really the same. Once observations were being made about the
equivalencies between the two different expressions of the numbers, conversations began to occur and students were discussing the problem with their partner.

Analysis from the first evaluative assessment show that 24 students scored at a satisfactory level and two students scored at an unsatisfactory level. Upon further review of the teacher field notes and student journal responses, the two students who scored unsatisfactorily on the evaluative assessment had a great deal of difficulty understanding and applying place value methods. Student 25 and 26 struggled with applying newly constructed mathematical knowledge and further analysis of their pre anxiety surveys showed that they had a medium to high level of mathematics anxiety.

Evaluative Assessment #2

I continued with the protocol by providing hands-on instructional strategies, such as cooperative groups and games, enhanced with technology, in a unit that was focused on adding and subtracting whole numbers and money. Many of the lessons that were used during the research period were lessons that focused around the concept of adding and subtracting whole numbers using place value. The majority of the problems presented were in a word problem format and the rest were written as a standard algorithm.

In a lesson that focused on subtracting whole numbers, I assigned cooperative groups the task of illustrating subtraction using base 10 blocks. In review of my teacher filed notes, I observed many groups beginning the problem by setting up both numbers first and then trying to subtract. Once the problem was set up on the floor many groups were unsure of what came next in the solution process. Student 6 commented to her group that it would be easier to solve the problem with pencil and paper. Student 3 offered a solution to her group that they should try taking the “second number” away from the “first number.” The group agreed with that idea and
followed through with the problem solving it correctly. That group was then asked to share their solution ideas with the class and offer another problem as practice. Analysis of the second evaluative assessments shows that student 6, along with three other students, did not pass satisfactorily. On the other hand, student 3 scored a perfect score and her group members scored in the satisfactory range as well.

As seen in Table 2, four students performed unsatisfactorily on the evaluative assessment. In contrast, the remaining 22 scored satisfactorily. Further analysis of the data showed that the four students who scored unsatisfactorily had high mathematics anxiety, based on the MARS-E (1988) pre- and post anxiety survey. Teacher field notes suggest that these four students struggled with the concept of utilizing manipulatives in addition and subtraction. They would ask if they could use pencil and paper to solve the problem, instead of using manipulatives.

Analysis of journals for these four students showed that they struggled with the concept of understanding a word problem. Student 2 commented, “I get confused with word problems. I sometimes don’t know what they are asking.” In agreement, Student 15 says, “I get all messed up when I see a word problem.” From this, I ascertained that two of the four students who scored unsatisfactorily had a great deal of difficulty with deciphering how to solve the problem before procedurally solving.

Data from teacher field notes showed that Student 15 would reluctantly begin his mathematics assignment and when asked if he needed help, his response would be, “I don’t know where to begin.” Student 10 would put her hands over her head and say that, “Math was too hard!” Such data from the students’ journals, evaluative assessments, and teacher field notes all show evidence of a mental struggle that four students incurred, while the remaining students
were confident with the construction of this knowledge and passed the evaluative assessment satisfactorily.

**Evaluative Assessment #3**

The focus of evaluative assessment #3 was multiplication and division concepts. An improvement was evident in students’ mathematical performance on this evaluative assessment (see Table 2). Three of the four students that performed unsatisfactorily on the second evaluative assessment, made great improvements in their mathematical performance in the third evaluative assessment. I gathered those three students and asked them about their success. Student 2 said that she felt more comfortable with multiplication and division and there were less word problems to solve. In careful review of the previous evaluative assessment to this one, the format is different. Student 6 said that he loved multiplication and division. He also commented about the fact that if you know your multiplication facts, then you know your division facts. In review of his journal during this unit, he was more involved in cooperative group activities and volunteered avidly during lessons. Student 10 made a slight improvement in from the second evaluative assessment to this one. She made several comments, noted in my teacher field notes, that math is just not her “thing” even if it is memorization.

Analyzing the data from the three prior evaluative assessments, there are still a large number of students in the class that are performing satisfactorily. Further analysis of the data illustrates that students 1, 3 and 21 have scored perfect scores on the evaluative assessments. Students 11 and 16 scored nearly perfect on the three previous evaluative assessments. I surmised from these data that this group is a high performing group of students. Careful examination of these students’ pre- and posttest percentile levels shows that some have a medium level of anxiety; however still perform well on assessments. Teacher field notes
indicate that the students comfort in performing mathematical tasks in front of their peers was increasing.

**Evaluative Assessment #4**

The fourth evaluative assessment had the greatest amount of students performing in the satisfactory level than the other two evaluative assessments (see Table 2). The class scored an average of 93% on the assessment. Students who had previously scored unsatisfactory percentages on the past two assessments raised their scores tremendously. Student 2, who scored a 60% on the second evaluative assessment, scored an 86% on this evaluative assessment. Student 6, who scored 68% on the second assessment, scored an 86% on the third assessment and a 99% on the fourth assessment. Student 10 scored a 67% on the second evaluative assessment, scored a 96% on this assessment. Lastly, Student 15, who struggled, scored a 50% on the second evaluative assessment, a 69% on the third assessment, and a 90% on the fourth evaluative assessment.

Student journals, student interviews, and teacher field notes for these students indicate that they enjoyed the technology integration into the unit of geometry. Student 15 said, “It helped me to understand it [mathematics] better.” When Student 6 was asked about her success, she commented “I liked being able to hold the geometric shapes, play on the computer, and play the matching game for shapes. I learned better playing games.” Similarly, Students 5, 13, 20 and 24 indicated that they learned more by manipulating geometric shapes on the computer and playing games. Further analysis into this rise in evaluative assessment scores lead me to find that the reception of the students in the area of technology had a large impact on their motivation to be successful in the geometry unit in mathematics, leading to successful performance.
Analyzing data taken while teaching the geometry unit, I reviewed my teacher field notes and student journals. To introduce the topic of transformations (movements), students were given the opportunity to explore a website that illustrated the geometric terms: translation (slide), rotation (turn), and reflection (flip). Students were instructed to work independently during this activity. Students were assigned a computer and asked to answer three questions using pre-selected websites. The questions were as follows:

- What happens to a figure when it has been translated?
- What happens to a figure when it has been rotated?
- What happens to a figure when it has been reflected?

Student 8 responded to the first question. “When a figure is translated, the shape looks the same just in a different place on the screen.” Student 23 responded to the third question. Her response was, “When a figure has been reflected it has been flipped over. Reflection is just a mirror image.” Some of the responses were as follows:

- When a figure is rotated it is on its axis.
- A figure moves when it gets translated.
- When a figure has been flipped the same object goes the opposite way it started out.
- When a figure has been translated it has slid over.
- The thing that happens when a figure is translated it, it stays faced the same way, but it just is in a different spot, by sliding. It has the same characteristics and things like that. It also moves in a straight line.

Teacher field notes compiled during this activity showed students to be engaged and positive about their learning experience using the computer. When students were interviewed and asked if they liked mathematics after completing this activity, all of the students responded positively. Student 10, who thinks mathematics is too hard, said, “I like using the computer to learn math. It [math] is fun.” Of the 26 students, 81% (21 out of 26) were able to answer the questions correctly, 8% (2 out of 26) were not able to answer the questions correctly and 12% (3 out of 26) were absent, therefore not responding. Careful review of the students’ work and the data sources
of student journals and teacher field notes indicated that the majority of the students performed successfully as a result of using technology to teach mathematics.

**Evaluative Assessment #5**

The fifth and final evaluative assessment scores were comparable with previous evaluative assessment scores (see Table 2). Only one student scored unsatisfactorily, student 15. In careful review of the attitudinal data, student 15 struggled with performing mathematical tasks since the beginning of the study. Analysis of the pre- and post anxiety survey (MARS-E, 1988) showed that his percentile level on the pre-test was a 30 and his percentile level on the post-test was a 75. This trend illustrates that the alternative teaching methods did not prove to be beneficial to this student in the area of academic performance, anxiety and attitude towards mathematics.

An example of a students’ positive mathematics performance was illustrated in the second lesson on estimating fractional size in relation to one whole. Students were working independently, using fraction tiles, to estimate their size in relation to 0, ½, or 1 using a number line. Various students used the fraction tiles to help them find their answer, while other students used the fraction tiles to check their answer.

Mrs. Hosack: Is 3/6 closer to 0, ½, or 1 whole?

Student 11: 3/6 is ½ because ½ and 3/6 are equivalent fractions. I figured that out in my head. Want me to show you?

Mrs. Hosack: Sure.

Student 11: First, you find your sixths, you need three of them, and then you place them under the 1 whole and you can see that it is exactly half.

Mrs. Hosack: What does that tell you about 3/6?
Student 11: That 3/6 and ½ are equivalent fractions. If you want, you can check it by placing the ½ under the three sixths and see that they are the same size.

This student in particular has a very low mathematics anxiety, according to the MARS-E (1988) and is a high performing student according to his academic performance and FCAT test results. During an interview, this student was asked if using fraction tiles during lessons were helpful in understanding fractions. He responded, “The fractions tiles help me to check my answer and if I don’t quite know what the answer is I can use the tiles and find it in a snap.” I also asked the student if he enjoyed using the fraction tiles. “I do enjoy using the fraction tiles because it helps, sometimes.” Additional students were asked the same question and some of their responses were as follows:

- Yes, these fraction tiles helped me understand the lesson because I did everything hands-on.
- I enjoyed using the manipulatives because I am visual.
- Yes, the fraction tiles did help me because then you could actually see the fractions.
- Yes, they did help me understand way (sic) better.
- Yes, they did because they were easy to work with and a lot of fun.

Overall student growth was monitored throughout the 12-week study using percentage scores as a form of measurement. By the end of the study, no real change was evident in the students’ scores. All but four of the students maintained strong scores on all five of the evaluative assessments. Student journals and student interviews indicated that Students 2, 6, 10, and 15 struggled greatly with the content in mathematics and the procedures used to solve mathematics problems.

Evidence of a change in students’ attitudes was shown using the pre- and post anxiety survey (MARS-E, 1988). This survey indicated that the majority of the students’ (69%) attitudes improved in the area of mathematics. Improved students’ mathematics attitudes were expressed
in the students’ journals and recorded in my teacher field notes during classroom discussions. All attitudinal data, students’ journal, student interviews, and teacher field notes were analyzed and triangulated with the pre- and post anxiety survey (MARS-E, 1988) and evaluative assessments throughout the 12-week study. By the end of the research period, all but one student had maintained successful performance on the assessments. However, the majority of the students maintained successful performance during the study.

Summary

The purpose of this study was to examine the effects of utilizing hands-on instructional strategies, enhanced with technology, on students’ mathematics attitudes and mathematics performance. Analysis of data revealed several themes about students’ mathematics attitudes, in reference to levels of anxiety, and performance, while hands-on instructional strategies, enhanced with technology, were combined with mathematics instruction. The first theme that emerged was that the combination of hands-on instructional strategies decreased students’ mathematics anxiety. The second theme that emerged was that students’ mathematics attitudes improved using hands-on instructional strategies. A third theme was the minimal effect that hands-on instructional strategies had on students’ academic performance.

When studied cumulatively, the data from students’ journal responses, student interviews, teacher field notes, pre- and post anxiety survey (MARS-E, 1988), combined with evaluative assessments indicate these fourth grade students had a decreased mathematics anxiety and an improved attitude toward mathematics. Hands-on instructional strategies, enhanced with technology, had little affect on students’ mathematics performance.

In chapter five, a discussion of the findings and conclusions drawn from those findings were discussed. A call for future research was also indicated.
CHAPTER FIVE: CONCLUSION

Introduction

The objective of this study was to determine the effects of using hands-on instructional strategies and technology on fourth grade students’ attitudes and performance in mathematics. Jackson and Leffingwell (1999) suggest that awareness without active solution toward mathematics instruction is meaningless. “Instructors can take an active role in reducing performance anxiety and can facilitate learning and enjoyment in mathematics” (Jackson & Leffingwell, 1999, p. 586). Throughout the research period, attitudinal data were collected to measure students’ overall mathematics attitude, using a pre- and post anxiety survey (MARS-E, 1988), student journal responses, student interviews and teacher field notes. Data to measure changes in academic performance were collected through five evaluative assessments.

These data were collected and analyzed and provided insight as to whether or not hands-on instructional strategies, enhanced with technology, affected students’ mathematics anxiety, as it relates to attitudes, and mathematics performance. In general, the students in my fourth grade class became more actively involved in mathematics lessons and activities utilizing hands-on instructional strategies enhanced with technology. Conclusions for the research questions, along with emergent themes, limitations, and recommendations are discussed below.

Conclusions

I conducted action research in my fourth grade classroom by combining hands-on instructional strategies, enhanced with technology, to my everyday mathematics instruction. Reading student’s journals gave me the opportunity to distinguish students’ strengths and
weaknesses along with likes and dislikes toward mathematics. As time passed students became more open and descriptive when writing about their opinions of a mathematics lesson or activity that used hands-on instructional strategies, enhanced with technology. As the teacher researcher, reading students’ journals enabled me get a clear picture of the students’ mathematics attitudes and the positive or negative changes taking place.

Talking with students during interviews and observing students during activities and lessons, I became a more thoughtful and empowered educator. When students were expressing a dislike toward mathematics, I made an effort to look at the activity within a lesson or the lesson itself and try to include the student or create a meaningful, fun situation. When the students were expressing positive feeling towards mathematics and the lessons or activities, a greater amount of effort went into maintaining that positive attitude toward mathematics. Students opened up during activities and lessons that included manipulatives, games, cooperative grouping, and technology. They were more engaged and in tune with the lesson and I saw the attitudinal benefits for students when combining mathematics instruction with hands-on instructional strategies.

The first research question was “How did hands-on instructional strategies enhanced with technology affect my students’ attitudes toward mathematics?” The pre- and post anxiety surveys (MARS-E,1988) were used to measure changes in students mathematics anxiety in response to using hands-on instructional strategies, enhanced with technology. Analysis of the pre- and post anxiety survey (MARS-E, 1988), it was discovered that the use of hands-on instructional strategies combined with mathematics instruction decreased students’ mathematics anxiety. Student expressed a positive attitude toward utilizing new techniques in the teaching and learning of mathematics. Such positive attitudes were evident in the post anxiety survey,
students’ journals, and teacher field notes. Stuart (2000) asserts, “The methods used to teach mathematics skills may affect whether a student feels successful and develops mathematical self-confidence.” (p. 331). Negative feelings towards mathematics have caused many individuals to have mathematics anxiety (Curtain-Phillips, 1999). The data revealed that combining hand-on instructional strategies into my mathematics instruction positively affected my students’ mathematical self-efficacy. An important component in the area of students’ mathematics anxiety was the hands-on instructional style and variation from their previous mathematical experiences.

At the beginning of the study, students expressed their general dislike for mathematics due to the level of bookwork that was being completed. Many students espoused a negative attitude toward mathematics because of the style in which it had been taught. At the end of the study, students were asked question #5, “Would you be more interested in learning mathematics if hands-on instructional strategies (manipulatives, games, cooperative groups, and technology) were used as an instructional tool?” Many students responded positively that they would like to use manipulatives such as base 10 blocks, geometric solids, and fraction tiles coupled with cooperative groups and learning games in learning mathematics. Data also supports the fact that combining hands-on instructional strategies with mathematics instruction, students experienced a decrease in their mathematics anxiety.

In addition to the decreased mathematics anxiety levels of the students, hands-on instructional strategies, enhanced with technology improved students’ mathematics attitudes. Students expressed their ideas and opinions about hands-on instructional strategies through journal prompts and student interviews. Throughout the study, analysis of students’ responses to
journal prompts indicated that the use of cooperative groups, games, manipulatives, and technology, positively affected students mathematics attitudes.

Interviews were held to further explore the mathematics attitudes of students throughout the study. Data from the students’ responses to interview questions illustrated the belief that mathematics instruction, combined with hands-on instructional strategies, assisted in the students’ construction of knowledge. Teacher field notes also support the claim that students’ attitudes became more positive when interacting in cooperative groups and were active in the construction of their own knowledge. Students responded that they were more involved in the mathematics lessons and enjoyed mathematics more because of hands-on instructional strategies. Townsend and Wilton (2003) avow that with certain instructional strategies, we may be able to increase perceptions of personal ability to learn and perform tasks in mathematics and reduce feelings of tension associated with these tasks.

My second research question was, “Hoes did hands-on instructional strategies enhanced with technology affect my students’ performance in mathematics? Evaluative assessments were analyzed to measure performance in mathematics. The underlying reason for utilizing hands-on instructional strategies and technology was to lead students to a better understanding of mathematics, in turn providing for a stronger performance. After analyzing this data, it was evident that little change had taken place in the area of performance based on the use of hands-on instructional strategies utilized during the study. However, student performance was not negatively affected by using hands-on instructional strategies.

Factors to consider when interpreting the findings were that little change took place in the area of performance due to the current academic level of the students who participated in the study. Analyses of the evaluative assessments were evidence that the majority of the students
were very strong academically. In looking at the students who participated in the study, 8 of the 26 (31%) students are identified as being gifted and 5 of the 26 (19%) are high achieving students based on the mathematics portion of the FCAT tested in the spring of 2005. These figures illustrate that 13 of the 26 (50%) students in the class are high achieving in the area of mathematics. These pieces of data support the claim that mathematics instruction combined with hands-on instructional strategies had little effect on student performance in mathematics.

Throughout this study, data had revealed that students experienced a decrease in mathematics anxiety and an improvement in mathematics attitudes. These benefits combined with the potential to affect students’ performance in mathematics have encouraged me to continue implementing hand-on instructional strategies, enhanced with technology into my daily mathematics routine. Students expressed a great deal of enthusiasm utilizing manipulatives, games, cooperative groups and technology, which was a motivator for me to continue with instruction that met the needs of my students. Analyzing student performance, it was evident that the use of hands-on instructional strategies, enhanced with technology, had the potential to increase student’s performance in mathematics. Successful student performance in mathematics means that the instructor is accurately facilitating the construction of knowledge.

Limitations

There were limitations to this study that affected the comparison of the findings to other classrooms. One limitation was the student sample size. The target population of all fourth grade students was condensed to an obtainable population of fourth grade students assigned to the teacher researcher’s fourth grade classroom in Sanford, Florida. Another limitation was the students’ participation in every activity, journal writing session, and interview used in the study.
Students were absent on occasion and inconsistent in participating in activities and lessons, which effected the consistency of the data. Students were not required to make-up the activities or assigned journal writings following an absence. A final limitation of this action research study was the availability of computers to support the use of technology when combining hands-on instructional strategies with mathematics instruction. Due to the numbers of students participating in this study and the number of computers available, technology was not used as often as planned.

**Recommendations**

After conducting this action research study, I see a need to conduct research further in the areas of students’ mathematics attitudes and mathematics performance. Due to the nature of this action research study of only 12-weeks, students’ attitudes and performance in the area of mathematics could be better researched over a longer period of time. Another recommendation would be a larger sample size. Additional qualitative research would need to be conducted with a larger and more diverse sample size. This study was conducted in an elementary school with a limited amount of ethnic diversity and a relatively small portion of the school (33%) falling in the category of economically disadvantaged. For that reason, the results of this study could be contingent on the type of population in this particular school setting. Further research would need to be conducted in a more diverse school setting.

While conducting my action research study on the effects of incorporating hands-on instructional strategies into the mathematics curriculum, I felt that a narrower approach to a specific area within mathematics would have facilitated the data collection process. For instance, if I had chosen a particular strand in mathematics, I may have been more effective in
tracking students understanding of that strand. In turn, I could more effectively assess the students’ performance and tracked students’ changing attitudes towards mathematics.

Another recommendation pertaining to this action research would be the implementation of focus groups into instruction. Affording students the opportunity to discuss mathematical ideas with other students in a controlled environment would strengthen their belief in their ability to be successful in mathematics. I believe that focus groups would foster student-teacher rapport and would provide additional insight into the student’s level of mathematics performance and mathematics attitudes. This one-on-one form of data collection would add depth to any further research done in the area of students’ mathematics attitudes and mathematics performance as a result of using hands-on instructional strategies.

Discussion

Fiore (1999) emphasizes, “Preventing and overcoming math anxiety begins with teachers and teaching strategies that develop positive and realistic self concepts” (p. 405). Throughout my research, I was able to measure the positive effects of hands-on instructional strategies, enhanced with technology, on students’ mathematics attitude and mathematics performance. By incorporating cooperative grouping, manipulatives, games, and technology into my mathematics instruction, the students’ anxiety towards mathematics decreased and students were able to maintain their current level of performance.

This research study afforded me the opportunity to learn a great deal more about my students and their feelings in regards to mathematics and the use of hands-on instructional strategies, enhanced with technology, in the mathematics curriculum. Students became very open as time progressed and I enjoyed reading their insights on the activities and lessons conducted throughout this study. I found it very insightful that students expect the teacher to
teach and the students to be “shown” how to solve problems. Learning this about my students encouraged me to foster in them a sense that they have the tools to solve the problems, they just need to know how to use the tools. The combination of mathematics instruction with hands-on instructional strategies has shown the students that they can solve problems and they do have the ability to be successful in mathematics.

This newfound knowledge led to an additional question about incorporating hands-on instructional strategies and technology into the mathematics classroom. How will these instructional techniques affect students’ long-term attitude toward mathematics? This question can be answered by tracking these students’ progress throughout their academic career. I predict that after participation in mathematics instruction combined with hands-on instructional strategies, students would show higher performance on the FCAT standardized test.

As a result of my study, I will be utilizing hands on instructional strategies, enhanced with technology as a central part of my mathematics instruction in the future. Aside of the student and teacher benefits detailed, I found that utilizing cooperative groups, manipulatives, games and technology to be powerful and valuable instructional tools. The students’ enthusiasm and positive attitude was evident in their journal responses and interview responses. Their effort was apparent as they integrated the use of hands-on instructional strategies into learning mathematics.

Hands-on instructional strategies proved to be a valuable tool to improve the quality of mathematics instruction in my fourth grade classroom. I am enthusiastic and hopeful that other teachers who read this research will combine mathematics teaching with hands-on instructional strategies into their everyday mathematics routines. I believe this reflective practice enhanced
my teaching ability and allowed me to successfully reach my students, fostering their individual learning levels.
APPENDIX A: MARS-E ANXIETY SURVEY
MATHEMATICS ANXIETY RATING SCALE-E (MARS-E)

The items below are about things that may bother you or cause you to be nervous or anxious or tense when you have to do them. Place a check ✓ in the circle that shows how nervous you would feel.

Here is an example:
Mark how nervous or anxious you would feel in adding 4 + 5.

If you would feel very nervous in adding 4 + 5, then you would place a check ✓ in the circle under "Very, very nervous".

Now do the following sample:
Mark how nervous you would feel in adding 976 + 50 in your head.

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<table>
<thead>
<tr>
<th></th>
<th>How nervous or tense would you feel if you had to solve this problem: George brought 4 boxes of toy cars to class. If each box had 7 cars, how many toy cars did George bring?</th>
<th>Not at all nervous</th>
<th>Not very nervous</th>
<th>Fairly nervous</th>
<th>Very nervous</th>
<th>Very, very nervous</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>2.</td>
<td>Mark how nervous or tense you would feel if you had to decide if this problem is right: ((3 + 4) + 2 = 4 + (2 + 3)).</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>3.</td>
<td>How nervous or tense do you feel reading this problem: Babe Ruth was known as the Home Run King. He had 54 home runs in 1920, 59 in 1921, and his best of 80 in 1928. How many home runs did he hit in all three years?</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>4.</td>
<td>Mark how nervous you feel when you have to add (976 + 777 + 458) on paper.</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>5.</td>
<td>If you had to add up a cash register receipt after you bought several things.</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>6.</td>
<td>When counting how much change you should get back after buying something, how nervous do you feel?</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>7.</td>
<td>When getting your math book and seeing all the numbers in it, how nervous do you feel?</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>8.</td>
<td>Getting called on by the teacher to do a math problem on the board (how nervous do you feel)?</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>9.</td>
<td>Raising your hand in math class to ask a question about something you don't understand.</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not at all nervous</td>
<td>Not very nervous</td>
<td>Fairly nervous</td>
<td>Very nervous</td>
<td>Very very nervous</td>
</tr>
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<td>---</td>
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</tr>
<tr>
<td>10.</td>
<td>Looking at how much two different sizes of two different kinds of soft drinks cost and deciding which is cheaper.</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>11.</td>
<td>Starting to read a hard new chapter for your math homework.</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>12.</td>
<td>Being asked by your teacher to tell how you got your answer to a math problem.</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>13.</td>
<td>Taking a big test in your math class.</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>14.</td>
<td>Sitting down to do your math homework on things you are just starting to learn.</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>15.</td>
<td>Thinking about a math test the night before the test.</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>16.</td>
<td>Thinking about a math test an hour before the test.</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>17.</td>
<td>Thinking about a math test 5 minutes before the test.</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>18.</td>
<td>Waiting to get a math test back on which you think you didn't do very well.</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>19.</td>
<td>Being given a set of multiplication problems to solve on paper.</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>20.</td>
<td>Being given a set of division problems to solve on paper.</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>21.</td>
<td>Having to figure out how much each of you owe when you buy a pizza and three soft drinks with two friends.</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not at all nervous</td>
<td>Not very nervous</td>
<td>Fairly nervous</td>
<td>Very nervous</td>
<td>Very, very nervous</td>
</tr>
<tr>
<td>---</td>
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<td>-------------------</td>
</tr>
<tr>
<td>22.</td>
<td>Counting your change after buying a movie ticket because you think you didn’t get enough money back.</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>23.</td>
<td>Figuring out what time it will be in 25 minutes.</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>24.</td>
<td>Figuring out if you have enough money to buy a candy bar and a soft drink.</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>25.</td>
<td>Having someone watch you while you correct your math homework on the blackboard.</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>26.</td>
<td>Listening as your teacher tries to help you see how to work a math problem.</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
</tbody>
</table>
THE UNIVERSITY OF CENTRAL FLORIDA
INSTITUTIONAL REVIEW BOARD (IRB)

IRB Committee Approval Form

PRINCIPAL INVESTIGATOR(S): Lindsey Hosack
IRB #: 05-2742

PROJECT TITLE: The Effects of Technology and Hands On Teaching Strategies on Fourth Grade Students' Attitudes toward Mathematics.

[X] New project submission
[ ] Continuing review of lapsed project #
[ ] Study expire
[ ] Initial submission was approved by expedited review
[ ] Initial submission was approved by full board review but continuing review can be expedited
[ ] Suspension of enrollment email sent to PI, entered on spreadsheet, administration notified

Chair
[ ] Expedited Approval
Dated: 7/20/2005
Signed by: [Signature]

[ ] Exempt
Dated: [Signature]

Expiration Date: 7/15/2006

NOTES FROM IRB CHAIR (IF APPLICABLE): Approved with modifications. First review 7/20/2005
APPENDIX C: ANXIETY SURVEY APPROVAL LETTER
Subject: Re: MARS-E
Ack Status: No Confirmation
Importance: None
Priority: Normal
Security: Normal

Creator: "Richard Suinn" <suinn@lamar.colostate.edu>
Distribution List: From: "Richard Suinn" <suinn@lamar.colostate.edu>
To: Lindsey_Hosack@scps.k12.fl.us
Created: 07/07/2005 19:43:28

Message Text:

Dear Ms. Hosack:

I have received your order for the Mathematics Anxiety Rating Scale-8 for use in your research. This gives you permission to use the copies I am mailing you for your study. The MARS-E instrument has been relied upon by other scholars seeking to measure levels of mathematics anxiety among elementary level students, so it should be relevant.

Signed,

Richard M. Suinn, Ph.D.
Emeritus Professor of Psychology
Colorado State University

http://mail.scps.k12.fl.us/Contact/mail/1120795664/jobno=42cc3e35/CMD=TEMPLATE1/... 7/8/2005
APPENDIX D: PRINCIPAL CONSENT LETTER
Dear IRB Coordinator,

Mrs. Lindsey Hasack has notified me with respect to the action research project she wishes to pursue during the months of August and December of this school year. The project involves the use of technology in conjunction with math instruction to determine its perception by students as a change agent in that content area.

I have reviewed the letter Mrs. Hasack will be sending home requesting the participation of her students. She does note their grades will not be impacted should parents elect not to participate in the study. Once I have been provided with the consent forms from parents, I will authorize Mrs. Hasack to conduct her proposed research project.

Sincerely,

Barry Liebovitz
Principal
I have read the procedure described in the letter by Mrs. Hosack dated August 1, 2005.

I voluntarily give my consent for my child,______________________ to participate in Mrs. Lindsey Hosack’s study on the effects of technology and hands-on instructional practices on student’s attitudes towards mathematics.

I voluntarily give consent for my child,______________________ to be video-taped during this research.

Parent Signature __________________________  Date __________

Parent Signature __________________________  Date __________
Child Assent

Good morning class! You probably don’t know that I go to school, too. I attend the University of Central Florida in the evenings. While you are in my class this year, I will be working on a research project. First, we are going to take an attitude survey to see how you feel about mathematics. Next, we are going to keep weekly math journals to help show how you feel about using technology and hands on activities in math. I will also be video taping some of our conversations about math. You may stop at any time and you do not have to answer any questions that you do not want to answer. Would you like to do this?
APPENDIX G: STUDENT INTERVIEW QUESTIONS
Interview Questions

Name: _____________________________________

1. Do you like mathematics? Why?

2. Does working in cooperative groups help you to learn mathematics?

3. How do you feel about using hands-on instructional tools (manipulatives, games, and cooperative groups, and technology) in mathematics?

4. Do you feel you are better able to understand math as a result of using hands-on instructional strategies (manipulatives, games, cooperative groups, and technology)?

5. Would you be more interested in learning mathematics if hands-on instructional strategies (manipulatives, games, cooperative groups, and technology) were used as an instructional tool?
1. What did you learn from the math lesson today?
2. Was it helpful working with a group? Why?
3. What scares you about math?
4. How did you feel about today’s math lesson? Why?
5. What was the most interesting part of today’s math lesson?
6. Was there a part of today’s math lesson that you already knew? What was it?
7. How do you feel about using hands-on instructional strategies (manipulatives, games, and cooperative grouping) and technology in mathematics?
8. What was the hardest part of today’s math lesson?
9. What was the easiest part of today’s math lesson?
10. What is your favorite teaching/learning strategy that we have used thus far?
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