LXD RESEARCH
AT CHARLES RIVER MEDIA

TOUCHMATH®

Summary of the study conducted by Stephanie Uzomah: *Teaching Mathematics to Kindergarten Students through a Multisensory Approach*

EFFECTIVENESS CASE STUDY

LXD Research, an independent research firm, conducted a third-party validation of a TouchMath case study. This report summarizes LXD's findings.

JUNE, 2025

TOUCHMATH®

EFFECTIVENESS CASE STUDY

Program Description

TouchMath is a leading provider of explicit, multisensory math programs designed to help students of all abilities understand foundational and abstract math concepts. TouchMath offers a comprehensive suite of instructional materials, professional development services, and digital resources.

Aligned to state and extended standards, TouchMath is widely used in special education programs and as a supplemental math solution for special student populations. Using TouchNumeral and TouchPoints, it helps students learn basic operations through a hands-on approach.

STUDY DETAILS

Location

Elementary School in Northeast Georgia, USA

Analysis Sample Size

- 50 students taught TouchMath
- 50 students not taught TouchMath

School-Level Demographics

- 49% Minority Students
- 45% Female
- 27% FRL
- % ELL in each sample
    - Comparison group: 44% ELL
    - TouchMath group: 48% ELL

Methodology

- Quasi-experimental study, with a convenience sample of naturally formed groups.
- Independent-samples t-test used to compare change & post-test scores in each condition.

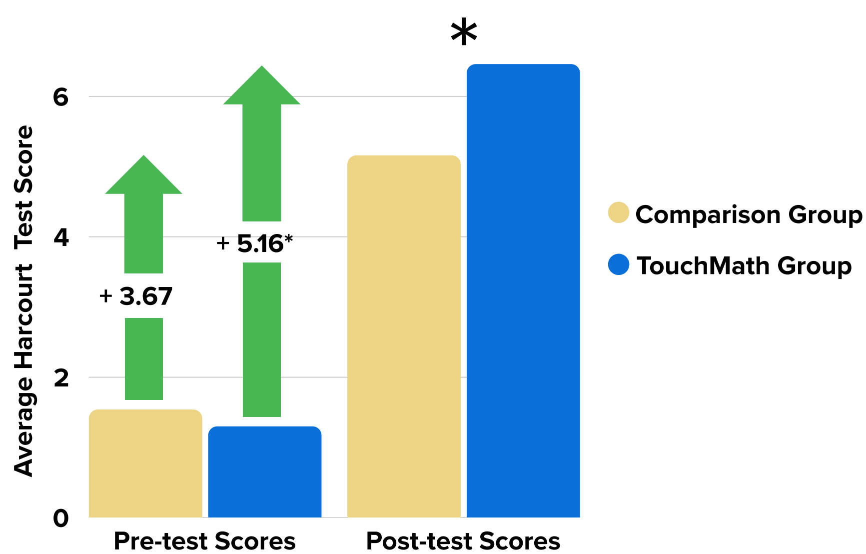
STUDY CONTEXT

These study findings were reviewed by LXD Research. Dr. Uzomah investigated the impact of the TouchMath program on kindergarten students' computation abilities. The study included six kindergarten classrooms at her Georgia Elementary school. Three classes were selected for TouchMath via convenience sampling, and taught by experienced TouchMath teachers; three classes received different mathematics instruction from teachers with similar experience levels. Sessions were whole- and small-group, 30 minutes daily, 5 days per week. All participants took the same pre- and post-test (the Harcourt Chapter Test), separated by a six-week period.

KEY FINDINGS

- Pre-test scores were similar across groups. However, the intervention group had significantly higher post-test scores than the comparison group* **($t(98)$ = .3.1, p = .002, Cohen's d effect size = .62.)**
- The comparison group improved by an average of **3.62 points** from pre- to post-test, while the TouchMath group improved by **5.16 points; a significantly greater increase ($t(98)$ = 3.7, $p < .001$, Cohen's d = .74).**

TouchMath Group: Higher Growth & Post-Test



TOUCHMATH STUDY DESIGN

100 Students → Pre-Test (Harcourt assessment) → 6-Week TouchMath Use → Post-Test (Harcourt assessment) → Analysis of Results

Study Citation:

Uzomah, S. L. (2012). Teaching Mathematics to Kindergarten Students through a Multisensory Approach. ProQuest LLC. 789 East Eisenhower Parkway, PO Box 1346, Ann Arbor, MI 48106.

Walden University

COLLEGE OF EDUCATION

This is to certify that the doctoral study by

Stephanie Uzomah

has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

Review Committee
Dr. Robert McClure, Committee Chairperson, Education Faculty
Dr. Freda Williams, Committee Member, Education Faculty
Dr. Brett Welch, University Reviewer, Education Faculty

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Walden University
2012

Abstract

Teaching Mathematics to Kindergarten Students

Through a Multisensory Approach

by

Stephanie Lynn Uzomah

MS, Walden University 2005

BS, Georgia State University, 2003

Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Education

Walden University

February 2012

Abstract

In 2007, only 32% of Georgia's fourth grade students were considered at or above the proficient level in mathematics. The purpose of this study was to examine the effectiveness of the TouchMath program at one elementary school. The TouchMath program was developed based on the constructivist learning theory and includes aspects of theories from Bruner, Gardner, and Piaget. The research question involved understanding difference in computational abilities between kindergarten students taught by the TouchMath program and those taught through traditional means. The research design was a quasi-experimental, quantitative nonequivalent control group design. An independent-samples t test was used to test whether there was a significant difference between instructional strategies and mathematical achievement. Results of the statistical test demonstrated significantly higher gain score in mathematics achievement for those who were taught using the TouchMath program. Implications for positive social change including providing effective instruction that can better prepare children with the foundation on mathematics that can enable them to compete globally.

Teaching Mathematics to Kindergarten Students

Through a Multisensory Approach

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December 2011

Dedication

This doctoral study is dedicated to my wonderful husband, Xavier, who has inspired me to become the person I am today. The perseverance of my son, CJ, inspired me to go after my dreams. Their constant support and encouragement is invaluable.

I also dedicate this to all of my current, former, and future students. My goal is to make mathematics come alive for young children, so they can grow to life-long learners.

Acknowledgments

I would like to express my gratitude to Dr. Robert McClure for his guidance throughout this process. His comments, editing, and support are greatly appreciated. I would also like to thank my husband and son for their patience as I spend numerous hours working on my study. They never stopped believing in me. I promise this is my last degree! Finally, I offer my gratitude to my friend Paula Thompson, who helped my stay focused, even when I was burned out. Her support and encouragement enabled me to complete this study.

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Section 1: Introduction

Introduction to the Problem

During the 1980s, kindergarten programs prepared children for their formal education. Today, most states have a tax-funded kindergarten program and 23 states have prekindergarten programs (U.S. Department of Education, 2007). Kindergarten programs have moved from an unstructured experiential play to a more academic-based curriculum (Elkind, 1991). The demands to have a more academic kindergarten classroom were a result from political agendas and pressure on school systems to perform well on standardized achievement tests (Elkind).

In 2002, President George W. Bush signed the No Child Left Behind Act (NCLB). The primary goal of this legislation was to improve student performance at the elementary school level. According to the Center on Education Policy (2008), after NCLB was established, “sixty-two percent of school districts had increased the amount of time spent in elementary schools on English language arts and/or math” (p. 23). As a result, teachers are using more traditional teaching methods (lectures and drill practice) to prepare students for standardize achievement tests.

With NCLB, educators are under pressure to ensure academic success of their students. Yet, the rigor of kindergarten programs may be developmentally inappropriate (Jewell, 2009). Protheroe (2007) stated, “an important key to developmentally appropriate mathematics instruction, at any age or grade level, is achieving a balance between teaching for conceptual understanding and teaching for procedural fluency” (p. 52). If students, at any age, memorize the information, it is likely they will not be able to apply the strategies. Sloane (2007) found educators should allow children opportunities to construct a deep understanding of the skill or concept. Providing students with math instruction through hands-on exploration to practice basic skills will help develop a firm mathematical foundation.

According to the "Nation's Report Card" (U.S. Department of Education, 2007), 32% of Georgia's fourth grade students were considered at or above the proficient level in mathematics. Five mathematical content areas are assessed: number properties and operations, measurement, geometry, data analysis and probability, and algebra. Within these five areas, computation is the foundational skill needed in all content areas. According to Vinson (2001) "Many studies now show that too many students in the United States have a moderate level of mathematics and an even lower level of conceptual knowledge" (p. 89). Using appropriate and concrete instructional materials is necessary to ensure that children understand mathematical concepts.

There appears to be two major concerns for educators. First, the problem of developmentally inappropriate teaching techniques and second, almost 70% of students only obtaining a basic level of proficiency on state mandated tests is a concern to educators (Jewell, 2009; U.S. Department of Education, 2007). "Effective math instruction begins with effective teaching" (Protheroe, 2007, p. 52). It is important for educators to know how children learn and their preferred learning style.

Gardner (1983) and Dunn and Dunn (1978) provided educators with the tools needed to tailor their instruction based on the learning styles and multiple intelligences of their students. Gardner created 10 distinctive multiple intelligences: musical intelligence, bodily-kinesthetic intelligence, logical mathematical intelligence, linguistic intelligence, spatial intelligence, interpersonal intelligence, intrapersonal intelligence, naturalist intelligence, spiritual intelligence, and existential intelligence. Gardner suggested that each individual manifests varying levels intelligences and each person has a unique cognitive profile. Dunn and Dunn found four modalities for which students learn: kinesthetic, tactile, auditory, and visual. Dunn and Dunn believed by teaching children in their preferred modality, it would increase their learning potential.

Piaget (1966) and Bruner's (1966) stages of development are also useful instruments for educators. Piaget and Bruner's stages of development allow educators to meet the needs of each student at their developmental level. Piaget identified four major stages of cognitive development that children and adolescents pass through to gain knowledge. They include: sensorimotor, preoperational, concrete operational, and formal operational. Piaget believed all children pass through these phases to advance to the next level of cognitive development. In each stage, children demonstrate new intellectual abilities and increasingly complex understanding of the world. Bruner developed a model of human development as a combination of enactive skills (manipulating objects, spatial awareness), iconic skills (visual recognition, the ability to compare and contrast), and symbolic skills (abstract reasoning). Piaget and Bruner's cognitive development stages have influenced psychologist and educators for the past 50 years. Implementing these strategies into the classroom environment, can provide students with effective instruction that will improve academic achievement.

There is an ongoing debate regarding the best practices for teaching young children mathematics and which curricular intervention will best contribute to their development and academic achievement (National Association for the Education of Young Children ([NAEYC], 2008). There is an abundance of research on mathematical programs available today, and according to Thompson (1997), educators should conduct extensive research to determine the most effective program for their students. Educators should find instructional methods that allow children to develop a deep understanding of the content at their developmental level. One of those programs is the TouchMath program.

The TouchMath program was found to have developmentally appropriate teaching strategies and has shown to improve students' computation abilities (Jarrett & Vinson, 2005; Newman, 1994; Scott, 1993). The TouchMath program has a multisensory approach to teaching math. TouchMath is a program that introduces young students to counting, addition, subtraction, multiplication, division, story problems, money, and fractions (Bullock, 2005). The TouchMath program takes the constructivist approach to teaching by incorporating Piaget (1966) and Bruner's (1966) developmental theories. According to Piaget and Bruner, most kindergarten students should begin learning mathematical concepts at the concrete level of development.

Using hand-on approaches will enable the students to physically touch an object while understanding the process. Once these basic skills are mastered, students can progress through the pictorial and symbolic stages. TouchMath also incorporates all major learning styles (Bullock, 2005). Students are able to see, say, hear, and tough the numerals and problems without directing their attention away from the paper. As a result, the TouchMath program provides children with developmentally appropriate instruction to increase mathematical achievement (Bullock).

School districts and educators are facing challenges brought about by NCLB. States and districts have created rigorous curriculums and high stake tests that students are required to pass (Jewell, 2009). This challenges educators to find educational programs to improve their students' academic achievement and increase test scores. Because there is a need to increase math achievement in Georgia's school, this research contributed to the body of knowledge needed to address the decreased conceptual knowledge in mathematics and examine developmentally appropriate teaching techniques using the TouchMath program.

Statement of the Problem

The problem addressed in this study is that at ABC Elementary School, in Northeast, Georgia, there was a 55% increase in the number of students who did not meet the minimal requirements between the 2004-2005 and 2005-2006 school years on the first grade mathematics section of the Criterion-Reference Competency Test [CRCT] (U.S. Department of Education, 2007). The U.S. Department of Education showed 68% of fourth-grade students in Georgia are meeting the minimum standards on state mandated tests. These deficits in math achievement, coupled with the stricter educational requirements and standards established by the NCLB, are a concern to educators in Georgia and at ABC Elementary School. Early childhood educators are trying to find a balance between developmentally appropriate practices and the required achievement benchmarks identified by NCLB (U.S. Department of Education).

Background of the Problem

Currently, early childhood educators are trying to identify and adopt more effective and developmentally appropriate instructional approaches for their students (Bullock, 2005). Developmentally appropriate practices particularly impact kindergarten students, who are not developmentally ready to address the rigors of NCLB (U.S. Department of Education, 2007). The National Council of Teachers of Mathematics ([NCTM], 2006) found in order to provide children with developmentally appropriate practices, the curriculum should provide mathematical instruction that keeps children actively involved. To help students stay actively engaged in the learning process, teachers should begin with concrete objects and move to pictures and diagram representations (Wadlington & Wadlington, 2008). The learning should also involve exploration, questioning, and constructing mathematical ideas (NCTM). Dev, Doyal, and Valente (2002) found to best prepare students, teachers have to spend a significant amount of time each day on math instruction and must teach students the foundations of mathematics. NCTM establish when children are exposed to a variety of learning experiences throughout the school day, children become confident in their ability to learn and perform mathematical tasks.

To meet the challenges addressed by NCLB and state mandates, educators should find the best methods to teach their students. Three teachers at ABC Elementary School are using the TouchMath program to help students improve their computation abilities and become more proficient on the CRCT; while six are using traditional teaching methods. Evidence presented in the research showed that the TouchMath program improves students' computation abilities (Jarrett & Vinson, 2005; Newman, 1994; Scott, 1993). I focused on the effectiveness of the TouchMath program with regards to the computation abilities of a group of kindergarten students. I examined the theories of constructivism by comparing the effectiveness of the TouchMath program on the Harcourt Math Assessment Guide (2004) at ABC Elementary School in a northeastern suburb of Atlanta, Georgia. Specifically, I determined if there was a difference in the computational abilities of kindergarten students who were exposed to the TouchMath program to those who were taught through traditional means.

Nature of the Study

I explored the TouchMath program in depth and its impact on kindergarteners' computation abilities over a 6-week time period. The research methodology was a quasi-experimental, nonequivalent control-group design. There were nine kindergarten teachers at ABC Elementary School; three teachers are currently using the TouchMath program, while six teachers are using traditional teaching methods. Utilizing three teachers who have experience using the TouchMath program for the experimental group and three who are using traditional teaching methods created a sample size of 100 participants and generalize the results of the entire population (Gravetter & Wallnau, 2005). This allowed me to investigate whether there was a difference between the TouchMath program and traditional mathematical teaching as it relates to students' computation abilities. Group A was the experimental group and received the treatment (the student group who used the

TouchMath program), while Group B was the control group (the student group who used traditional math instruction). The methodology included collecting pre and posttest data using the Harcourt (2004) chapter test (Appendix A) to determine if a significant difference exists between the experimental group and the control group regarding computation achievement and different instructional strategies. This design investigated the differences between the independent variables of instructional strategies, including the TouchMath program, on the dependent variable of computation achievement. To test the null hypothesis, an independent-sample *t* test was used as the statistical test to compare two different sets of data, taken from two different mathematical instructional strategies.

In this quantitative study, I used a convenience sample. The students were a convenience sample selected in accordance with the school's entrance data and the software program Elementary Class Assigner by MacKinney Systems, Inc. The participants included 100 students from six kindergarten classrooms. Each class had 16 or 17 students. The total number of participants was assigned to their respective kindergarten classrooms based on enrollment data. Three classrooms represented the experimental group and three classrooms represented the control group. All participants were divided evenly in terms of age, gender, and entrance data.

The pre-existing Harcourt (2004) chapter pretest established each student's computational abilities prior to the TouchMath instruction or traditional math instructional strategies. The six classroom teachers then introduced the students to the TouchMath program or traditional math instructional strategies over the 6-week period.

The TouchMath program was a supplemental program used at ABC Elementary School and is used in three kindergarten classrooms. The three teachers who used the TouchMath program followed specific lesson plans noted in Appendix B. The three teachers who used traditional teaching methods followed regular educational activities found in Appendix C. All experimental sessions were conducted in a whole and small group format. Each whole group session was conducted five days per week for 30 minutes a day. Students who were struggling received small group instruction with a paraprofessional for an additional 20 minutes per day. During that time, the teachers assessed the students' progress through teacher-created assessments. At the end of the study, the students were given a Harcourt chapter posttest. Scores were collected and analyzed using descriptive statistics. Statistical analysis determined if the students' computation abilities improved. A more detailed discussion of the research methodology is presented in section 3 of this doctoral study.

Research Question

The following research question was addressed in this study: Is there a difference in computational abilities between kindergarten students taught by the TouchMath program and those taught through traditional means?

H_0: There is no significant difference in math scores for kindergarten students who are exposed to the TouchMath program compared to those who are taught through traditional means.

H_1: There is a significant difference in math scores for kindergarten students who are exposed to the TouchMath program compared to those who are taught through traditional means.

These hypotheses were designed to assess the growth of kindergarteners' computation achievement using the TouchMath program. Based on these hypotheses, the independent variable was the method of instruction-traditional math instruction or the TouchMath program. The dependent variable was the student's computation abilities, which was measured using the Harcourt Math Assessment Guide (2004) chapter test containing eight addition problems. The participants of the study were 100 kindergarten students at ABC Elementary School in a northeast suburb of Atlanta, Georgia. The experimental groups, or Group A, consisted of students who were taught using the TouchMath program and the control group, or Group B, consisted of students who were taught through traditional means. The instruments (pretest and posttests) were administered to Groups A and B.

Purpose of the Study

The purpose of this quasi-experimental quantitative study was to evaluate the relationship between math instructional methods and the computation abilities of a group of kindergarten students at ABC Elementary School in a northeastern suburb of Atlanta, Georgia. I examined the theories of constructivism by comparing the effectiveness of the TouchMath program on the Harcourt Math Assessment Guide (2004). Specifically, I determined if there was a difference in the computational abilities of kindergarten students who were exposed to the TouchMath program compared to those who were taught through traditional means.

Theoretical Basis of the Study

The theoretical basis for this study was the constructivist learning theory. It was developed by many educational researchers including Bruner (1966), Gardner (1983), Piaget (1966), and Vygotsky (1986). According to Lambert et al. (2002), "The constructivist learning theory assumes that learners bring experience and understanding to the classroom" (p. 26). The teacher's role is to create a link between that informal knowledge and the formal math concepts that are taught in school. As the learners acquire new information, they will assimilate or accommodate the new information they have learned (Lambert et al., 2002). Educators help their students do this using many methods and mathematical programs. One such program is the TouchMath program. Using the TouchMath program, students are able to create more knowledge and reflect their learning, thus increasing their mathematical knowledge (Bullock, 2005).

The TouchMath program is based on the constructivist learning theory and includes many educational researchers' theories such as Bruner (1966), Gardner (1983), and Piaget (1966). Gardner's theory of multiple intelligences maintains there are 10 distinctive intelligences ascribed to human beings: musical intelligence, bodily-kinesthetic intelligence, logical mathematical intelligence, linguistic intelligence, spatial intelligence, interpersonal intelligence, intrapersonal intelligence, naturalist intelligence, spiritual intelligence, and existential intelligence. He found that children have preferred ways of thinking and processing information. Gardner suggested individuals have a unique cognitive profile that has varying levels. The TouchMath program allows educators to adapt the lessons to meet the needs of students using a multisensory approach to learning. These methods allow students to receive instruction using more than one sense. This will enable students to learn through the intelligence that will suit their needs.

The TouchMath program aligns with the developmental theories of Piaget (1966) and Bruner (1966), which helped to develop the constructivist approach to learning. According to these experts, when learning a new concept, children and adults progress through stages of intellectual development. As they move through the stages of development, students gain an understanding of the concept being taught. Piaget (1975) believed children develop through four stages: sensorimotor, preoperational, concrete operations, and formal operations. In the sensorimotor stage, children acquire their own knowledge through physical interactions. In the preoperational stage, children cannot conceptualize abstractly and need concrete representations to learn a concept. The next stage is concrete operations. In this stage, children can think more abstractly and can learn abstract concepts. The final stage of development is the formal operations. During this stage, the child can see mental representations of mathematical concepts without the use of manipulatives (Vinson, 2005). Kindergarteners are in the preoperational stage of development. When performing mathematical operations, kindergarten teachers should provide their students with manipulatives as an instructional method.

The TouchMath program allows teachers to adapt the lessons to suit the needs of the students at their developmental stage according to Piaget's (1975) stages of cognitive development. For example, students who are in the concrete stage will have the TouchPoints on the numbers to represent the quantity of the number or to solve the mathematical equations. This will enable students to visually see the quantity of the number or help in solving the mathematical equation. When students move to formal operations, the TouchPoints are removed and they are aware that a number represents a quantity without the help of manipulatives and TouchPoints.

Bruner (1966) found that when learning new concepts, students progress through three stages: concrete, pictorial, and symbolic. The concrete stage involves hands-on experiences. During this stage, the learner should use manipulatives when solving mathematical equations. In the pictorial stage, the learner needs visual images to understand the concept. This can include pictures to solve equations. The symbolic stage allows the learner to use numbers or symbols for the learning to occur (Gallenstein, 2005). During this stage, learners are able to solve mathematical equations using paper and pencil. When learning a mathematical concept, students need to internalize ideas using methods that are meaningful to them. Students move through the stages of development to get a clear understanding of the concept being taught (Gallenstein). When learners are learning the quantity of the number or exploring the method of solving addition problems, they progress through the same stages of development.

Bruner's (1966) cognitive learning theory may be incorporated into the concepts and skill of the TouchMath program. In the concrete stage of development, students can place objects on the numerals representing the TouchPoints (Bullock, 2005). In the pictorial stage, the TouchPoints or dots are located on the numbers to help students visualize the quantity of the number or aid in solving computation problems. Using the TouchMath program in the symbolic stage, students use the numeral to symbolize the amount. Bruner's stages of development will enable the learner to learn the concept being taught at their developmental stage, thus increasing their self-confidence and developing more complex skills at their level of development.

Piaget (1966; 1975) and Bruner (1966) focused on the process of cognitive development, whereas, Vygotsky (1978) placed emphasis on the social contributions. Vygotsky's theoretical framework is that social interaction play a fundamental role in the development of cognition. Vygotsky played an important role in the development of constructivism. He believed children must take an active role in the learning process and learning should occur though social interactions. Vygotsky stated:

> Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, between people (interpsychological) and then inside the child (intrapsychological). This applies equally to voluntary attention, to logical memory, and to the formation of concepts. All the higher functions originate as actual relationships between individuals. (p. 57)

A second aspect of Vygotsky's theory is that the potential for cognitive development depends upon the zone of proximal development (ZPD). ZPD is attained when children engage in social behavior. Vygotsky found that the concept or skill can be developed with adult guidance or peer collaboration exceeds what can be attained alone.

Using the TouchMath program, educators can incorporate Vygotsky's (1978) theoretical framework into their instruction. Educators are aware of the numerous ways to solving mathematical equations (Burns & Silbey, 2000). Children should be given opportunities to hear the multiple ways their peers may have solved the equation (Burns & Silbey). When using the TouchMath program, some students may choose to count all of the TouchPoints on the numbers when adding. Whereas another student may say the larger number and count only the TouchPoints on the smaller number (Bullock, 2005). Both methods are effective when adding two numbers, but the student that simply counts all the TouchPoints, may not know there is another method to obtain the same answer. Math instruction should focus more on the process than on the computation and using only one method to solve a problem (Burns & Silbey).

Educators should also use developmentally appropriate teaching strategies to ensure students understand mathematical concepts (Bullock, 2005). The TouchMath program stresses both the understanding and the application of mathematical concepts, which allows students to perform computations accurately without the use of manipulatives. Using Bruner (1966) and Piaget's (1966; 1975) stages of development will allow students to move through at their own developmental rate. This enables students to internalize ideas using methods that are meaningful to them (Feldman, 1999). Vygotsky's (1986) theoretical framework allows children to learn from one another, while Gardner's (1983) multiple intelligences allow children to learn in their preferred interest. Incorporating multiple learning strategies into ones instruction can have a significant impact on student achievement.

Definition of Terms

Constructivism: A philosophy of learning founded on the premise that "learners bring experience and understanding to the classroom" (Lambert et al., 2002, p. 26). Children and adults generate rules and mental models, which are used to make sense of our experiences. Learning is simply the process of adjusting our mental models to accommodate new experiences (Lambert et al.).

Developmentally appropriate educational practices: "Education that is based on both typical development and the unique characteristic of a given child" (Feldman, 1999, p. 201). The emphasis is on child-centered learning activities which utilize materials that are concrete and age appropriate.

Direct Instruction: A teaching technique that was developed in the 1960s. The instruction is "face paced, teacher-directed, prescribed, and explicit with all children receiving instruction on a pre-specified sequence of activities at the same time" (U.S. Department of Education's Institute of Educational Sciences, 2007, p. 3).

Math manipulatives: Concrete objects that can be manipulated by the learner in order to explore or attain mathematical knowledge. Examples include: pattern blocks, tangrams, and snap cubes (Charlesworth, 2008).

Student achievement: The levels at which students perform on standardized assessments (Fosnot, 1005). For this study, the standardized assessment is the Harcourt Math Assessment Guide (2004) chapter test.

TouchMath: A comprehensive program to teach counting, addition, subtraction, multiplication, division, story problems, time, money, and fractions. The program has a multisensory approach to teaching math (Bullock, 2005).

Traditional mathematical teachings: The predominant methods of math instruction in which the instruction is teacher-directed (Beyer, 2008).

Assumptions

There are several assumptions that were made within the research design.

1. Based on the subsequent review of literature, the TouchMath program is a developmentally appropriate program and will improve students' computation abilities (Jarrett & Vinson, 2005; Newman, 1994; Scott, 1993).

2. The three teachers in the study who used the TouchMath program were knowledgeable about the TouchMath program and its components.

3. The three teachers using traditional teaching methods were knowledgeable about the delivery of math instruction.

4. The teachers involved with the study provided their students with TouchMath instruction or traditional math instruction 5-days a week for 30 minutes a day.

5. The classrooms utilized are representative of the total kindergarten enrollment.

6. All the participants worked to the best of their ability while engaged in the method on math instruction given by the instructor.

Limitations

There were several limitations to the study.

1 I used a convenience sample due to the limited number of kindergarten classes at ABC Elementary School.

2 A random sample was not utilized, which causes limitations, such as systematic bias and environmental differences (Creswell, 2003).

3 Another limitation of this study was the involvement of only six teachers. Their different instructional styles, quality, training, and experience are potential weaknesses.

4 Since all of the kindergarten teachers do not teach math at the same time of the day, a limitation to the study was the time of day math instruction occurs. A full day kindergarten program can be tiring for students, and if math is taught at the end of the day, the students may not be as focused.

5 The final limitation was the student's attendance or nonattendance during instruction.

Scope and Delimitations

The scope was centered on the impact the TouchMath program had on selected kindergarteners' computation abilities at an elementary school located in the largest school system in Georgia. Data retrieved from NCES (2007) showed there are 1,127 students at the elementary school. The student body consists of 580 male students and 508 female students. The student body comprises 538 European Americans, 248 African Americans, 181 Hispanic Americans, 125 Asian Americans, and 1 Native American student. Twenty-seven percent of the students receive free or reduced lunch services (NCES, 2007).

At ABC Elementary School, there are nine kindergarten classes, each with approximately 15 -18 students. All kindergarten teachers are certified in Early Childhood and all nine hold Masters Degrees in related fields. Out of the nine kindergarten classrooms, six participated in this study.

The delimitations of the study include:

1. This study was delimited to one elementary school in northeastern suburb of Atlanta, Georgia.

2. The sample was limited to six kindergarten classrooms, of which three classes were taught using the TouchMath program and three classes were taught through traditional mathematics instruction. All of the participants were given the same pre and posttest.

3. Only kindergarten students were used in the study.

Significance of the Study

Parents, educators, and policy makers are concerned with the level of proficiency on state mandated mathematical tests, including the CRCT. Hayes (2008) found "lagging U.S. scores on comparative international tests continue to create pressure to concentrate on the type of instruction that traditionalists believe will be most effective in raising test scores" (p. 153). Educators are searching for a mathematical program that will increase students' computation abilities and provide developmentally appropriate practices.

Local Problem

The research from this study impacted and informed parents, teachers, and administrators in the district on the developmentally appropriate teaching strategies that the TouchMath program encompasses. A comprehensive study of the TouchMath program is beneficial to early childhood educators and the local school system to determine the quality, significance, and impact the program has on students' mathematical achievement. This study directly addressed the need to identify mathematical strategies that may improve the percentage of students achieving proficient and beyond on the "Nation's Report Card" and the CRCT (U.S. Department of Education, 2007). I also examined developmental aspects of mathematical instruction to determine whether the TouchMath program is an effective method for increasing computation abilities in kindergarten students. The insight gained from this research could help teachers to identify instructional approaches that are developmentally appropriate and strategies that increase students' computation abilities.

Professional Application

Designing a curriculum for improving mathematics education can be part of systemic education reform, including national standards that contribute to state and local districts. Legislators, superintendents, school board members, administrators, and educators are responsible for providing effective mathematics instruction and materials to students. These stakeholders have the power to provide improvements in mathematics achievement. The research has the potential to be a changing force for this school's teaching practices and increase students test scores on the CRCT.

A study on the effects of the TouchMath program on kindergarteners' computation abilities is important for several reasons. Educators are looking for a teaching method that is developmentally appropriate and will improve student achievement. Additionally, there is a limited amount of research available on the TouchMath program. The available research lacks longevity and a large number of participants (Jarrett & Vinson, 2005; Newman, 1994; Scott, 1993). This study was conducted over a 6-week period and had approximately 100 kindergartener students participate.

The TouchMath program teaches students the foundations of mathematics, which will enable teachers to build upon what students already know. The importance of mathematical skills and knowledge is essential. "Educators must prepare all students to compete globally in a world that relies on using mathematics" (Furner & Berman, 2003, p. 170). Early childhood educators should provide students with a firm mathematical foundation to ensure as more complex skills are introduced, they are able to apply that new knowledge. In turn, this study could impact social change by providing students with the appropriate math instruction for them to compete in today's high-tech society.

Impact on Social Change

If schools are to become the promoters of social change by going beyond the building of intellect, instructional methods, such as the TouchMath program, is necessary for effecting change that will benefit students. The results of this study will contribute to positive social change by providing research on instruction and student learning. Instructional methods, such as the TouchMath program, may be necessary tools for effecting change that will benefit the academic achievement of students. This research has the potential to be a changing force for ABC Elementary School's teaching practices. The potential for social changes in mathematics may guide improvement in student achievement and develop proficient mathematicians in the elementary setting. In fact, information from this study may be useful to all persons interested in promoting academic excellence.

In order for social change to occur, legislators, superintendents, school board members, administrators, and educators are given the important task of improving mathematics education for students. These stakeholders have the power to provide reform needed to meet the requirements set forth by NCLB for improvements in mathematics achievement. It is important for teachers to improve their teaching practices and create lifelong learners. This study addressed social change by determining and supporting research aimed at preparing children with the foundation on mathematics to enable them to compete globally by becoming proficient in mathematics.

Summary and Transition Statement

The rigorous curriculum and state mandated tests set-forth by NCBL is a concern amongst educators. Developmentally appropriate mathematical instruction is vital to the success of kindergarten students. "Policies that affect the kindergarten curriculum should be developed through a careful process that incorporates the best information about how young children grow and learn" (Peck, McCaig, & Sapp, 1988, p. 31). I examined the TouchMath program to determine if it improves student's computation abilities and improve the academic achievement at ABC Elementary School.

The TouchMath program was found to have developmentally appropriate teaching strategies and has shown to improve students' computation abilities (Bullock, 2005; Jarrett & Vinson, 2005; Newman, 1994; Scott, 1993). The TouchMath program enables children as young as 4 and 5 years old to accelerate their comprehension abilities in mathematics (Bullock). The main purpose of TouchMath is to provide age appropriate mathematical instruction to primary school children. Providing children with developmentally appropriate math instruction can make a positive influence on students' learning. The TouchMath program stresses both the understanding and the application of mathematical concepts (Bullock).

The research methodology for this study was a quasi-experimental, quantitative nonequivalent control-group design. Mathematical achievement scores were used to compare a group of students who were taught using the TouchMath program to those who were taught through traditional mathematical teaching methods. The experimental group used the TouchMath program and the control group used traditional teaching methods. Both groups were selected without random assignment and took a pre and posttest. The population consisted of six kindergarten classrooms with 16 or 17 students in each class at ABC Elementary School. To test the null hypothesis, an independent-sample *t* test was the statistical test used to compare two different sets of data, taken from two different mathematical instructional strategies.

Section 2 is a comprehensive review of related literature as it pertains to constructivism, developmental learning theories, math achievement, and the TouchMath program. Section 3 is an explanation of the research design and methodology for the study. The findings of the study and the analysis of the data are discussed in section 4 and the summary, conclusions, and further recommendations are addressed in Section 5.

Section 2: Literature Review

Introduction

The purpose of this study was to evaluate the effectiveness of two instructional methods on the computation abilities of a group of kindergarten students. I focused on the TouchMath program and traditional mathematical teaching practices. An investigation into peer reviewed journals and books about constructivism, learning styles, developmentally appropriate teaching practices, and math instruction were the foundation of this research.

Key terms used to access the literature were: *child development, constructivism, developmental learning theories, developmental difference, learning styles, academic achievement, mathematics instruction, the TouchMath program,* and *prior related studies.* The literature was exhausted using ProQuest, Educational Resource Information Center (ERIC), and Google Scholar.

Background

Parents, educators, and policy makers are all concerned about what and how well students are learning and applying mathematical concepts (Protherone, 2007). In order for students to be successful mathematicians, educators should take several factors into consideration when planning math instruction. “Math instruction required individuals to work in a specific direction, follow steps correctly, and work in an organized way” (Wadlington & Wadlington, 2008, p. 3). Teachers should begin each math lesson with a description of the big idea of the lesson, then breaking down the skills into small parts and present them in step by step fashion. New vocabulary and math terms should be presented to the students using concrete examples (Wadlington & Wadlington). Teachers should model concepts and students should be given many opportunities to have guided practice. According to Wadlington and Wadlington, modeling and guided practice are key for a student's success.

Educators have experienced how children differ from one another and these differences should be addressed in the classroom. Levy (2008) found lessons should address a student's ability level, learning style, and interests. Once an educator has determine the child's learning style, interests and cognitive abilities, adaptations to the lesson will enable the learner to be more successful, without losing site of the curriculum. Gardner (1983) is an advocate of the theory of multiple intelligences. Gardner proposed there are at least 10 different intelligences: musical intelligence, bodily-kinesthetic intelligence, logical mathematical intelligence, linguistic intelligence, spatial intelligence, interpersonal intelligence, intrapersonal intelligence naturalist intelligence, spiritual intelligence, and existential intelligence. Gardner believed educators need to attend to all of the intelligences to promote student success. Dunn and Dunn (1978) found there are four basic modalities of processing information using visual, tactile, auditory, and kinesthetic means. Dunn and Dunn's model found a learners' learning style allows him/her to concentrate on, process, absorb, and retain information; thus, enabling the learner to accelerate their learning. A learning style is different than multiple intelligences. Multiple intelligences attend to what is taught and a learning style addresses how it is taught. Both methods are important to the academic success of learners. Implementing Gardner's theory of multiple intelligences or Dunn and Dunn's learning model into every lesson, will ensure the students are learning at their preferred learning style.

A final consideration that educators should take into account when planning their instruction is the child's developmental level of learning. Piaget (1966) and Bruner (1966) have contributed to the educational system and how children learn. Piaget found children learn through four distinctive learning stages, which include the sensorimotor, preoperational, concrete operational, and formal operational. Piaget believed in order for children to pass from one stage to another, they must reach the physical maturation and have the necessary relevant experiences (Feldman, 1999). Without these experiences, children are incapable to reach their cognitive potential. Educators should know their students learning stage to provide appropriate instructional tools to help students reach their cognitive potential.

Bruner (1966) found when learning a new concept, children and adults progress through three stages of intellectual development: enactive, iconic or pictorial, and concrete. Unlike Piaget (1966), Bruner believed that children may skip stages if they had well-developed intellectual skills in a particular stage. Bruner's approach appeared to have environmental and experiential factors, whereas Piaget believed the role of maturation determined the learners' cognitive development. When educators implement Piaget and Bruner's approaches to cognitive development into their instruction, the learner will be able to progress through their learning stage at their own pace. As a result, the learner acquires mathematical understanding at their appropriate stage of development.

As Dev, Doyal, and Valente (2002) found, “practitioners and researchers generally agree that basic mathematical concepts must be acquired before students can be expected to learn complex operations” (p. 330). When students do not have a strong mathematical foundation, they are likely to be placed at risk for math difficulties (Dev et al.). This presents a growing problem concerning developmentally appropriate math practices for kindergarten students and the most effective way to deliver mathematical concepts. According to Peck, McCaig, and Sapp (1988), “policies that affect the kindergarten curriculum should be developed through a careful process that incorporate the best information about how young children grow and learn” (p. 31). The National Association of School Psychologists ([NASP] 2008), encouraged schools and early childhood educators to provide students with developmentally appropriate instructional strategies that will cater to each child’s needs.

Educators are aware of the many ways to teach children mathematics. Research has been done on numerous math programs to provide evidence that a targeted program improves students’ mathematical abilities (Clements & Sarama, 2008; Mac Iver & Mac Iver, 2009; Riordan & Noyce, 2001). The TouchMath program is one of these interventions (Jarrett & Vinson, 2005; Newman, 1994; Scott, 1993). The TouchMath program takes a multisensory approach to teaching mathematics. Research shows TouchMath reaches a variety of learners, builds strong math skills, and raises test scores, while adhering to the child development protocol (Jarrett & Vinson; Newman; Scott). The TouchMath program closely aligns with child development philosophies of Bruner

(1966) and Piaget (1966; 1975). This section outlines the pertinent scholarly literature related to key components of the TouchMath program.

Child Development

The United States is considered a melting pot of many ethnic and cultural groups. Within these groups are a variety of family configurations. These can include single parent households, blended families, adoptive families, children living with grandparents, and families with same sex parents (Charlesworth, 2008). Within these family units are different values, experiences, educational levels, and socioeconomic statuses (Anderson, 2008). A child's home life can have a negative or positive effect of their learning potential. There is a decrease in cognitive development of students who are living in poverty (Cousins, Mickelson, Williams, & Velasco, 2008). Lee, Daniels, Puig, Newgent, and Nam (2008) showed students in low-income households may show a decrease in academic achievement. Lee et al. believed "to optimize learning environments and to maximize the potential of at-risk student groups who continue to achieve below the level of other student groups, school counselors must understand which factors contribute to academic success and learn to identify the factors that interfere with academic success" (p. 306). Ysseldyke and Bolt (2007) found by monitoring academic achievement and adjusting the curriculum to meet the needs of the students will result in higher test scores. School counselors, teachers, and parents play important roles in creating a supportive environment that fosters each child's growth and development.

To assist students who are in disadvantaged schools, Connecticut interdistrict magnet schools offer a choice-base desegregation to reduce racial and economic isolation. Thus allowing student's from Connecticut's central cities access to better schools. Bifulco, Cobb, and Bell (2009) researched the impact of attending a magnet school on student achievement by promoting integration to reduce racial and economic isolation and improve education outcomes for poor and minority students. Bifulco et al. collected data from the Connecticut State Department of Education to compare the pretreatment scores to the post treatment. The results showed a positive effect on high school student's math and reading achievement.

Anderson (2008) defined development as "the complex, dynamic changes that occur throughout the lifespan" (p. 1). Anderson found it is important for educators to know how children develop, grow, and learn. According to the National Association for the Education of Young Children ([NAEYC] 2009), physical, social and emotional, and cognitive development are closely interrelated. To teach children well involves fostering their development in all learning domains.

Physical development is important to young children. Most physical development for young children involves a form of play. According to Charlesworth (2008), play is vital component of learning for young children. Play can appear in a variety of forms. When children are playing on the playground, they may be running, climbing, or skipping. In a classroom environment, students may be playing in a housekeeping area or with blocks. Play allows not only physical development, but social and cognitive development as well. Studies show when play is involved, children's engagement and academic gains follow (Charlesworth).

To foster school age children's intellectual development, it is important for educators to provide multiple learning opportunities using hand-on play (Anderson, 2008). The teacher's role is to "provide a stimulating environment and guide their investigations through individual, meaningful interactions" (Anderson, p. 86). To support a child's cognitive growth, there are many theories that educators can implement to ensure children are learning at the appropriate cognitive stage of development (Bruner, 1966; Piaget, 1966; Vygotsky, 1986). A discussion of these theories will be discussed later in this doctoral study.

To foster student's social and emotional developments, Ostrosky and Meadan (2010) found educators should provide opportunities for play. This can enable them to build relationships, develop empathy, learn to take turns, and resolve conflicts. Ostrosky and Meadan found preschool children develop confidence, good peer relationships, listening skills, how to effectively communicate, concentration, and problem solving skills through cooperative play. Teachers should set-up these cooperative learning environments carefully to help develop these skills. It is also important to note, children may not know the appropriate ways to take turns or resolve conflicts. Role-playing is one way to show students how to develop these skills. It is important for educators to monitor these cooperative learning opportunities and provide support and encouragement to help develop these complex skills.

There are several factors that may contribute to the lack of parental involvement including time constraints and different cultural expectations of the teacher's role. "In today's fast-paced society, teachers and families face competing demands for their time, energy, and resources" (Souto-Manning, 2010, p. 82). Parental involvement is associated with a decrease achievement gap of non-English speaking students (Lahaie, 2008; Souto-Manning, 2010). Souto-Manning found to obtain parental involvement, teachers should meet with parents and find culturally relevant ways to build the interest of the child. According to Lahaie, many schools that do not take into consideration that cultural diversity of the students, may cause the student to fail. Lahaie determined Head Start programs, listening to music, and creating relationships with parents will increase English proficiency.

Nelson (2005) examined children's homes and preschool programs to determine if they had an impact on achievement when they entered kindergarten. Nelson found parents who engage in formal and informal learning activities on a regular basis, built a stronger foundation for future learning. Nelson also found when children attend preschool programs, it leads to an increase in math achievement in kindergarten.

The NAEYC (2009) suggested early childhood practitioners should be aware of the sequential methods that children development. This includes a child's physical, intellectual, social, and emotional developments. To develop these essential skills, educators need to know what developmental level the child is currently at and how to foster the skills that the child may be lacking. Encouraging parental involvement can also increase student's cognitive development.

Constructivism

Constructivism is defined as "the theory of learners constructing meaning based upon their previous knowledge, beliefs, and experiences-and their application to schools"

(Lambert et al., 2002, p. 1). The teacher's role is to create a link between that informal knowledge and the formal concepts that are taught in school. Lambert et al. also found, "the constructivist learning theory assumes that learners bring experience and understanding to the classroom" (p. 26). The prior knowledge that students have acquired is a foundation for educators. Teachers can then build upon that prior knowledge and expand upon the new knowledge they will gain through their formal learning experiences. Constructivists believe learning should "actively engage students in purposeful situations that involves collaboratively formulating questions, explaining phenomena, addressing complex issues, or resolving problems" (Gagnon & Collay, 2001, p. 127). These learning opportunities will enable students to connect their prior knowledge to new learning experiences, thus increasing their knowledge and understanding of a skill or concept.

Constructivists focus on students being actively engaged in their learning through the manipulation of materials and social interactions. In a classroom setting, constructivism can be seen in many variations. One key principle is the learning environment. The learning environment should be set-up where it stimulates knowledge (Iran-Najad, 1995). According to Draper (2002), with calls for mathematics reform, teachers have been challenged to move away from teaching by telling and move toward the constructivist teaching paradigm. The constructivist paradigm suggests that the learner creates their own knowledge based on their interactions with the environment and others. According to Lambert et al. (2002), educators should create a learning environment that allows learning to be a social activity where children can share ideas with others, thus gaining a more in-depth knowledge and understanding of a specific concept. Powell and Kalina (2009) found “constructivist teaching strategies have a great effect in the classroom both cognitively and socially for the students” (p. 241). Using effective tools, such as conversations and discussions, will enable students to become better communicators, while increasing their cognition (Powell & Kalina).

One method which allows students to share their thoughts and ideas is cooperative learning groups. This provides students with opportunities to share their ideas with others through social discourse (Brooks & Brooks, 2001; Magnesio & Davis, 2010). Collaborative learning groups are one such way to allow students to work together to accomplish a specific goal, while enabling the students to learn from each other. Summers (2006) found when students are grouped together they are more engaged in the lesson. They are also able to support each other’s learning and hear multiple explanations on ways to solve the same problem. Lambert et al. (2002) found learners are able to acquire a deeper understanding of the concept when they are able to share their thoughts and ideas with others. Constructivists rely on teaching practices that are rich in conversation. Through these conversations, the teacher comes to understand what the learner is prepared to learn, and how to orchestrate experiences and more conversations so that the learner is able to construct meaning, understanding, and knowledge (Draper, 2002; Esmonde, 2009). As a result, the student is creating knowledge instead of consuming information. Educators should also provide students with opportunities to question, probe, and ponder the concept. Draper suggested instructional plans should be carefully laid out as to what the learner wants to learn and organize experiences to enable the students to construct their own meaning and understanding.

Heck (2008) conducted a 2 year study with 9,196 students at 156 elementary schools to determine if teacher effectiveness was related to student achievement in reading and mathematics. Heck found an increase in accountability when student data is linked to their teacher. Typically states keep detailed records of student achievement. However, only 30% of states link the data to a particular teacher. In this study the accountability of teacher and students may have had an impact on the results; which showed teacher effectiveness is related to a difference in student achievement.

Templeton, Neel, and Blood (2008) found students with Emotional Behavior Disorder (EBD) struggle in all academic areas, especially mathematics. They studied math interventions for nine to 12 year olds with EBD. Templeton et al. deviated from teacher directed learning and focused on cooperative learning and peer tutoring. They found that changing the instructional delivery did not show a significant different in academic achievement in students with EBD.

The constructivist teacher asks open-ended questions and encourages students to question each other (Goran & Braude, 2007; Nelson & Sassi, 2007). Asking questions plays a vital role in student understanding. When teachers create opportunities for student thinking through open-ended questions, it allows students to seek answers and construct their own knowledge and understanding (Gagnon & Collay, 2001). According to Brooks and Brooks (2001), “posing narrow questions for which one seeks a singular answer denies teachers the opportunity to peer into students’ minds” (p. 86). In order for this to occur, teachers should create a classroom environment where the students feel safe and are aware that it is okay not to know the "right" answer. When a student does not know the correct answer, it is the teacher's responsibility to delve into the child's mind and determine why they came up with that response. When teachers allow students to have the opportunity to share their thoughts and ideas, it can be an empowering experience for the student.

Another key principle of constructivism is the role of the student in the learning process (Lambert et al., 2002). Teachers should create an environment where students are responsible for their own learning (Brooks & Brooks, 2001). It is the role of the teacher to provide the students with the necessary materials and supplies for the learning task to occur and mediate the students' learning. Daniels (2010) found when teachers create an engaging learning environment, students see the value of learning and become intrinsically motivated. Another role of the student is the ability to reflect and self-assess their learning. By doing so, students can discover to construct their own knowledge and meaning. "Student self-assessment makes the process for learning explicit to students, shaping their personal schema and enabling them to actively engage with new learning in the future" (Lambert et al., 2002, pp. 27-28). Lambert et al. found this form of assessment enables the students to be accountable for their learning and can intrinsically motivate students to want to learn.

A constructivist teacher creates authentic learning opportunities and assessments (Bush, 2006; Helm, 2008). Gagnon and Collay (2001) found that providing students with real-life learning opportunities allow students to deeply internalize the knowledge.

Meaningful tasks are more difficult for teachers to create and are usually not found in textbooks. However, when students are presented with meaningful lessons, the learner is more engaged in the lesson and creates a deeper understanding of the content (Lisenco, 2006). These meaningful learning experiences are relevant to the student and are stored into their long term memory. To ensure the student is learning, assessments should be done throughout the learning process. When researching curriculum design, Childre, Sands, and Pope (2009) found for students to obtain a deep understanding of the curriculum, assessments should contain explanation, interpretation, application, analysis, synthesis, and self-evaluation components. They found formative assessments help to target a deeper understanding of the content. This can be executed through student interactions with other students, student and teacher interactions, and response journals. These authentic assessments enable teachers to hear the students thought process. "Because authentic assessment tasks require students to apply prior knowledge to new situations, the teacher is able to distinguish between what students have memorized and what they have internalized" (Brooks & Brooks, 2001, p. 97). Multiple-choice tests, on the other hand, only inform the teacher on what students know on a particular topic. The goal of the constructivist teacher is to help students to internalize and reshape the new information to create a deep understanding of the concept.

Constructivist Classroom Verses Traditional Classroom

According to Hayes (2008), many teachers are not able to create a student-centered learning environment and are teaching through direct instruction in order to cover the required curriculum mandated by the state. Direct instruction is a teaching technique that was created in the 1960s. This form of traditional math instruction involves teacher-directed lectures, modeling, and step-by-step directions (Beyer, 2008). Direct instruction is taught in a whole group format and is a fast-paced method that many students are not able to keep up with. Students tend to recall the procedures short term and have difficulty with higher level mathematical applications (Chapko & Buchko, 2004). Students that are taught in this method may not perform as well on state mandated tests. Chapko and Buchko found

> Even though research tells us math teaching that focuses on rote memorization of facts and processes, supplemented by heavy doses of "drill and kill" homework, doesn't provide students with understanding of mathematical concepts, many of us continue to follow this "tried-and-true" method of instruction. (p. 31)

Math instruction should be more student-centered, where the child is able to learn as his or her pace and developmental level. Educators should merge teacher directed learning, student discovery, and hands-on instruction so all students become successful mathematicians (Chapko & Buchko). By educators knowing the students cognitive stage of developmental and the students learning style, they are able to incorporate these skills and strategies into their classroom to ensure the success of their students.

When comparing a constructivist and traditional classroom environment, one would be able to visually see and hear the differences. In a traditional classroom setting, the curriculum is presented in a part to whole method to emphasize basic skills. The students are typically working independently and the activities rely heavily on textbooks and workbooks (Brooks & Brooks, 2001). Llewellyn (2005) found many traditional teaching methods involve the use of rote learning and repetition. When the teacher asks questions in a traditional classroom environment, the students are to provide the correct answer to confirm their learning.

When one enters a constructivist classroom, there is a very different classroom environment. The students are primarily working in cooperative learning groups and are actively engaged in the learning process. Lessons are carefully laid out to encourage students to think and explore. This method will keep the focus on the learner. This will "help the learners to internalize and reshape, or transform, new information" (Brooks & Brooks, 2001, p. 15). The use of differentiated instruction is typically used in a constructivist classroom (Cakici & Yavuz, 2010). Cakici and Yavuz found this form of instruction made learning more meaningful and engaging. In a constructivist classroom, the curriculum is presented in a whole to part method with the emphasis on the big ideas. The students are taught through hands-on approaches and the teacher becomes a facilitator. The teacher asks open-ended questions, which allows the students to come up with multiple responses to the question (Brooks & Brooks; Goran & Braude). The teacher is able to assess the students learning through observations, response journals, and portfolios.

Cakici and Yavuz (2010) researched 33 fourth grade science students to determine if they would make significant academic gains using the constructivist approach compared to students who were taught through traditional teaching methods. During the 6-week study, the students in the constructivist classroom engaged in meaningful lessons that were student-entered. The students worked in small group activities and conducted hands-on experiments interacting with their classmates and the materials. The students in the traditional teaching classroom participated in whole group lessons where the teacher followed the textbook without any hand-on activities. Their research found a significant difference in the academic achievement of students who were taught using the constructivist approach of instruction when compared to the traditional teaching methods.

Isikoglu (2008) studied the effects of a teaching methods course on preservice early childhood educators' beliefs. The third year preservice teachers were exposed to a variety of pedagogical theories, including traditional teaching methods. Isikoglu wanted to determine if preservice teachers' beliefs would changed after taking and implementing a constructivism course. The preservice educators implemented the used discovery learning, inquiry learning, questioning, discussions, and role playing in the classroom. At the end of the 15-week course, the preservice teachers' beliefs about the constructivist approach of learning became stronger and the beliefs about traditional teaching roles decreased. They were able to see first-hand the importance of the constructivist theory and creating child-center lessons.

Policymakers are looking for students to perform well on standardize tests. Therefore, many teachers are teaching in a manner to prepare the students to take multiple choice tests. However, this form of teaching may not provide the students with a deep understanding of the concept that is taught. It is stored into the student's short-term memory, which only allows them to perform well on the test. The constructivist view is to enable the student to have a "deep understanding, not imitative behavior" (Brooks &

Brooks, 2001, p. 16). As a result, students are able to retain the information into their long term memory.

Mathematics and Constructivism

Draper (2002) found with calls for mathematics reform, teachers have been challenged to move away from teaching by telling and move toward the constructivist teaching paradigm. The constructivist approach for teaching mathematics involves the type of classroom activities and the way students and teachers talk about math (Larochelle, Bednarz, & Garrison, 2009). Creating a classroom environment which allows children opportunities for free exploration and conversations with other peers and adults is beneficial to all students.

A key element for children to increase their knowledge in science and mathematics in the early childhood level is through active, creative, intellectual engagement (Charlesworth & Lind, 2003). Through exploration, children learn many mathematical concepts, such as counting, matching, patterns, and classifying (Wallace, Abbott & Blary, 2007). These informal learning experiences will allow students to bring prior knowledge to the forefront of mathematical concepts (Wallace et al., 2007). Many experts believe that young children have a significant amount of informal knowledge about mathematics. Vowell (2008) found when students are provided hands-on activities with social interactions, they are able to develop conceptual knowledge based on their prior knowledge and understanding. Teachers can then create a bridge between that prior knowledge and the current information.

Eisenhauer and Feikes (2009) conducted research using the Connecting Mathematics for Elementary Teachers project to help prospective teachers connect their learning of mathematics to how children learn and understand mathematics. They found children come to school with a great deal of mathematical knowledge and teachers can help children connect this knowledge to mathematical concepts. Eisenhauer and Feikes found through guided exploration and asking open-ended questions, students were able to bridge their prior knowledge and expand upon it.

The nature of mathematics is “doing” (Fosnot, 2005). The concept of “doing” using traditional teaching methods would involve the teacher telling and showing the students how to perform the task, followed by drill practice worksheet to see if the students “know” the concept. This form of teaching is a one dimensional method. Students may memorize the procedures in hopes they retain it for the test. In a constructivist approach, the concept of “doing” is through meaningful activities which engage the students in the mathematical activity. Mathematical concepts should be taught where the students are participating in hand-on activities where they are able to manipulate the materials to come up with the correct solution (Wallace et al., 2007).

Garrett (2008) found the importance of creating a constructivist student-centered environment, where students were able to hear multiple view points through collaboration and teachers created authentic learning opportunities. When teachers create meaningful lessons, it allows the students to develop a deep understanding of the concept. In mathematics, this is important because many mathematical concepts build upon each other. If students are taught through traditional methods and only retain the information short-term, when the concepts become more complex, they are going to have a more difficult time with the learning process. Poncy, McCallum, and Schmitt (2010) found when students are given the opportunity to solve math problems using their own strategies without explicit directions from the teacher, they develop a deep understanding. Creating a learning environment, where the students can internalize and apply the concept, will enable the student to build upon the concept and learn the more complex mathematical skills, while gaining a deep understanding on the concept.

Sharing information and knowledge is important for children when learning mathematical skills and concepts. After researching the barriers that English Language Learners (ELL) face, Anderson (2008) found it is important for teachers to provide a stimulating environment and guide their investigations through individual, meaningful interactions. It is also essential for teachers to ask open-ended questions to encourage creative thinking. Anderson found it is vital for children to share their thoughts and ideas with other children. This will allow children to see the multiple ways of solving mathematical equations. Young children learn in a variety of ways including verbal interactions with peers and adults and hands-on play. It is the role of the teacher to ensure the classroom environment is set-up in a way to encourage the cognitive and social development of young children.

Developmental Learning Theories

Educators look at children as individuals. However, when planning lessons to foster their learning, teachers are able to predict what will cultivate learning and the academic and social development of children. Many constructivists created theories to help identify child development that focuses on the growth of a child and how learning takes place. Constructivism has evolved from a theory of learning to a theory of knowing. There are many theories and theorists that have contributed to the principles of constructivism including Bruner (1966), Piaget (1966; 1975), and Vygotsky (1986). These learning theorists have had a major impact on the manner in which educators deliver their instruction.

Bruner

Bruner (1960) has had several notable findings on education by discovering the nature of the learning process and the relevance it has on the educational process. Bruner believed the transfer of knowledge can be achieved through appropriate instruction. However, for children to reach their optimal potential, educators should know how children think and learn. Bruner found instruction should be based on the experiences of the learner and what he/she is able to learn. Next, how the instruction is laid out for the child to learn should be specified so that child can reach their optimal potential. Subsequently, educators should determine the sequence in which a concept should be learned. Finally, the pacing of rewards and punishments should be identified. With these discoveries, educators are better able to plan their instruction to suit the needs of their students.

Bruner (1960) found that teaching and learning is more than “simply the mastery of facts and techniques, [it] is at the center of the classic problem of transfer” (p. 12). This challenges educators to make a connection between a child’s prior knowledge and the current information that is taught. Bruner believed that

> Every effort should be made to educate the teacher to a deep knowledge of his or her subject so that he or she may do as good of a job as possible with it, and at the same time the best materials should be made available for the teacher to choose from. (pp. 15-16)

When a teacher has limited knowledge about the subject, he or she is not able to relay the information in a manner in which the children can gain an in depth understanding. A teacher's role is to educate children and they should have the necessary knowledge and tools to successfully do so. Once a teacher has the appropriate knowledge about the subject matter, they are able to determine the students' prior knowledge and build upon what they know about the content.

Bruner (1960) stated "learning in school undoubtedly creates skill of a kind that transfers to activities encountered later, either in school or after" (p. 17). The transfer of knowledge is the goal of the learning process. This transfer of skills, knowledge, or general ideas, can be used as a basis when learning new material. This continuous learning will broaden and create a deeper understanding of the original knowledge. In order for this transfer of knowledge to occur, educators should create a curriculum with a strong base to enable students to build upon what they know about the subject (Bruner). Once educators are aware of what needs to be taught, they can focus on how the subject matter should be taught.

Bruner (1966) believed "instruction consists of leading the learner through a sequence of statements and restatements of a problem or body of knowledge that increase the learner's ability to grasp, transform, and transfer what he is learning" (p. 49). He found when learning a new concept, children and adults progress through three stages of intellectual development. The first stage is enactive. During this stage, the concept should be concrete. This occurs when the focus is on the object. The use of manipulatives and encouraging children to use their senses will help children learn during this stage. The second stage is the iconic or pictorial stage. Throughout this stage, one needs visual images to understand the concept or skill. Bruner found children attain knowledge and awareness that a picture can represent an object during this stage. The third stage is the symbolic stage. This involves symbols, such as numbers and words. In this stage, the learner uses numbers or symbols for the learning to occur. Each symbol represents a picture, object, or action from the earlier stage (Gallenstein, 2005). It is important to note, Bruner discovered there is not a specific sequence for all learners. He found if a learner has a well-developed symbolic system, it may be possible to skip the first two stages.

Learning can entail a short episode or can last for a long period of time. Bruner (1960) found the actual act of learning contains three basic processes. The first is the acquisition of new information. This may be a refinement of past knowledge or the replacement of previous knowledge. According to Bruner, the second act of learning is transformation. Transformation is using previously obtained the knowledge and utilizing it in a new task (Bruner). The final aspect of learning is evaluation. This evaluation is used to assess if the knowledge was manipulated into a given task correctly. These acts of learning enable educators to determine a child’s readiness to learning and if they have successfully transferred the knowledge.

In order for learning to occur, educators should set an appropriate pace for learning. This varies depending on the age of the children and should contain a balance between extrinsic and intrinsic rewards. If the students are actively engaged in a lesson, they may be intrinsically motivated and not need any rewards from the teacher. Bruner (1960) believed when learning is done through discovery, children tend to be more intrinsically rewarded based on the desire to gain knowledge. However, when longer learning episodes occur, the students may need extrinsic rewards. Bruner felt educators should begin with extrinsic rewards and as the learner progresses, they will become intrinsically motivated.

Bruner's main focus was on how children think and learn and ways to help them gain knowledge (Gallenstein, 2005). He believed that the "theory of instruction is *prescriptive* in the sense that it sets forth rules concerning the most effective way of achieving knowledge and skills" (Bruner, 1966, p. 40). This has made a significant impact on the ways educators teach young children. Educator's awareness of the learning process enables knowledge to be transferred accurately. Focusing on the child's stage of development allows teachers to choose the necessary materials to use to reach the child's optimum learning potential. Finally, Bruner found using intrinsic and extrinsic rewards maybe needed when longer learning episodes occur.

Piaget

Piaget (1966; 1975) was a constructivist who developed an in-depth view on how children develop and construct knowledge. Piaget created a unique approach to how children construct their own knowledge through four distinctive stages. He also indicated how to implement these theories into an educational setting. He found that children learn best through discovery play with other children.

Piaget (1975) believed children develop through four stages as they move from birth to adolescence: sensorimotor, preoperational, concrete operational, and formal operational. The sensorimotor stage begins at birth and continues until a child is two-years-old. Children acquire their own knowledge through physical interactions. During this stage, children use their senses-touch, taste, sight, sound, and smell, to learn new information. According to Piaget, as new concepts arise, the child constructs mental maps or schemes. Schemes are "organized patterns of sensorimotor functioning, a representation in the nervous system of action upon the world" (Feldman, 1999, p. 184). Schemes are based on experiences of the child and are the "basic structure underlying the child's overt actions" (Ginsburg& Opper, 1969, p. 20). As a child interacts, they will acquire more experiences and their schemes will be modified based on the new experience.

The next stage of development is the preoperational stage. This is stage begins at age 2 and continues until age 7. In the preoperational stage of development, children cannot conceptualize abstract concepts and need concrete representations to learn a concept. During the preoperational stage, children have not acquired the mental processes of formal operations and are unable to think logically or have conceptual understanding. Piaget believed children in this stage, use symbolic function, which is the ability to use mental symbols, words, or objects to represent something that is not physically present.

These images or symbols will begin to be assimilated and accommodate as the child's cognitive abilities grow and change.

Reyes (2010) found when creating centers in the classroom which involve a form of play, such as blocks, adding an extension activity enabled the students to learn many academic concepts and skills. The children in Reyes' kindergarten class were in the preoperational stage of development, according to Piaget. During this stage, children need concrete objects to learn concepts. Through hands-on activities and play, Reyes found children learn many concepts and skills.

The next stage is concrete operations. This stage begins at age 7 and lasts until age 12. In this stage, children can think more conceptually and can learn abstract concepts. Piaget found that children at five-years of age can begin to develop these skills. Children are able to maintain appropriate conservations during this stage. However, they shift back and forth between the preoperational and concrete operational stages of development. Arefi and Alizadeh (2008) study did not have the same findings as Piaget. Arefi and Alizadeh studied the effected of bilingualism on the cognitive development using Piaget's conservation theories. With a population of 135 bilingual students in first, third, and fifth grades, their study showed an increase in age predicted the cognitive stage of development.

Piaget (1966; 1975) discovered there are specific methods to help students gain knowledge. He believed students should be actively engaged in their learning and learning should be child-centered to allow for discovery. Children learn best when real world experiences are presented. Piaget believed learning is driven by a child's natural curiosity. This enables educators to create a learning environment where children seek out answers, while developing their thinking skills and increases their problem-solving skills. To encourage this behavior, the activities should be open-ended; which allows teachers to ask open-ended questions to stimulate a child's thinking. As a result, children look at several aspects of the subject and are able to accommodate the information. Piaget's research found teachers should provide instruction that is appropriate for their level of cognitive development. If children are pushed too far into the next stage of development, they will likely become frustrated and confused (Feldman, 1999). Piaget suggests instruction should be individualized as much as possible and educators should provide instruction that is slightly higher than their cognitive level (Feldman). This will help prepare children to move to the next stage of development without frustration.

Piaget (1966) believed that there are several underlying factors that will promote a child's development, including play and social interactions Piaget felt play is an important vehicle for a preschooler's cogitative growth and development. He found three form of play including: practice, symbolic, and games with rules. He found toddlers participate in practice play, which involves repeating the same activities over and over. Symbolic play is typical behavior of a preschooler. This form of play occurs when a child is pretending to be something, such as a superhero or mother. The final form of play is games with rules. School age children participate in this type of play. This can include imaginary games or game boards with set rules (Ginsburg & Opper, 1969). These forms of play will develop language, literacy skills, and social behaviors.

According to Piaget (1966), educators should know their students capabilities and limitations in order to provide them with instruction that is developmentally appropriate. Feldman (1999) found this will enable children to learn concepts and grow the child's understanding and quality of knowledge. Piaget's stages of development will guide a teacher's decision when developing lessons and activities for young children. Piaget believed in order for children to pass from one stage to another, they should reach the physical maturation and have the necessary relevant experiences. Without these experiences, children are incapable to reach their cognitive potential.

Vygotsky

Vygotsky (1986) focused on the cognitive development of children based on the social aspects of development and learning. Vygotsky believed children's cognition was dependent on the social interactions with others (Feldman, 1999). He found that children increased their knowledge, thinking processes, beliefs, and values with the help of others. This should involve both child-adult and child-child interactions to increase ones' cognitive abilities. Vygotsky found to increase a child's cognition, educators should set-up classroom environments which involve discovery and social interactions.

Vygotsky (1986) believed that classrooms should be filled with rich conversations in order to increase children's cognitive development. Children are able to learn from other children, as well as adults. Vygotsky found past experiences and prior knowledge is built upon when obtaining new knowledge and skills that are influenced by others' culture and experiences. These encounters provide opportunities for children to help one another achieve a common goal through social interactions. Through these social interactions, children are not only achieving a given task, they are learning how to carry out the task and the most effective way to accomplish it (Ginsburg & Opper, 1969). Vygotsky (1986) believes teachers should encourage conversations with peers and adults.

One of Vygotsky's (1986) most important theories is the zone of proximal development (ZPD). Vygotsky found when children can almost, but not fully perform a task, instruction should be carried out with assistance from someone who is more capable. When children receive help through the ZPD, the support they receive leads to cognitive growth and encourages independence. Vygotsky termed this as scaffolding. Vygotsky believed scaffolding promoted problem solving, but it also aided in a child's intellectual development (Feldman, 1999). A student's prior knowledge and skills create the foundation for scaffolding and potential academic development (Shabani, Khatib, & Ebadi, 2010). In order for early childhood educators to implement ZPD into their classroom, they should observe children to lay out an educational plan to meet the needs of the individual child. Vygotsky (1986) believed for children to obtain the maximum level of support, teachers should be keen observers. Through these observations, educators can tap into the child's learning process to determine the educational needs of the child (Mooney, 2000). In addition, children can also learn from each other when they are paired up appropriately.

According the Charlesworth (2008), learning in a shared experience between an adult and child. This form of learning is a type of assisted discovery. Children are encouraged to learn through discovery with assistance from peers or adults to accelerate their learning. Vygotsky (1986) believed learning should be self-initiated. He found educators should set-up an environment that promotes learning. Vygotsky noted that this is a form of indirect assistance when the teacher is able to provide for the students, such as setting up the environment to guide the students learning. This environment should include real objects and opportunities for social interactions.

Vygotsky (1986) has played a significant role in early childhood education. Educators found the importance of social interactions and play to improve a child's cognitive development, based on Vygotsky's learning theory. Vygotsky found ZPD interaction with adults or peers enables students to accomplish a task which they may not be able to perform independently. This enables the child the guidance they need to accomplish a given task.

Developmental Differences

When children enter kindergarten, they are at different social, emotional, and academic levels. This may be due to the child's age upon entering kindergarten, the child's prior knowledge, or other environmental factors. The developmental differences are significant and educators should be aware on how to meet the diverse needs of the students.

The enrollment age of a kindergartener varies from state to state. To enter kindergarten in California, children must turn 5-years-old by December 2nd, while in Georgia, children have to turn five by September 1st (U.S. Department of Education, 2007). Therefore, teachers may have students ranging in age from 4-year-olds to 6-year-olds in their classrooms. With this significant age range, educators should keep in mind Bruner (1960) and Piaget's (1966; 1975) stages of development.

Along with the required ages for children to start kindergarten, some states require students to have assessments to determine if they are ready to start school (Ackerman & Barnett, 2005). These screenings can determine the child's cognitive, social, emotional, and physical development. Many use this information to determine if a child is ready to enter kindergarten, if there is a disability, or for class placements purposes. However, these assessments do not take into account a child's socioeconomic status (SES) or the student's primary language, which can make the test bias due to the lack of exposure (Ackerman & Barnett). Rielly (2008) studied 200 fifth grade students who were given the Developmental Indicator's for Assessment of Learning third edition (DIAL-3) in preschool to determine if it is a predictor for future academic achievement. The results showed less than 20% of the variances in future achievement. Rielly believes the preschool students who were considered "at risk" may be due to the lack of experience and prior knowledge. Vellutino, Scanlon, Zhang, and Schatschneider. (2008) found many students who were labeled as "at risk" were false positives. Vellutino et al. found screenings did not show a significant impact on a student's kindergarten readiness.

Children come to kindergarten with a broad range of knowledge and skills. Some children attend pre-kindergarten or Head Start programs where they are exposed to a variety of language arts and math skills. Others visit the library and read with their parents or care givers on a regular basis. Yet, there are children who have a limited exposure to these skills. A student's prior knowledge may significantly impact how they will perform in school. Howes, Burchinal, Pianta, Bryant, Early, Clifford, & Barbarin (2008) found children who attended a formal educational setting, such as pre-kindergarten programs, prior to kindergarten showed greater academic gains than those who did not. Almost 3,000 children in state-funded pre-kindergarten programs in 11 states were randomly selected. The data showed students who were enrolled in these pre-kindergarten programs showed larger gains in academic knowledge and skills (Howes et al.). Children with a limited amount of prior knowledge will need an environment that supports their individual needs.

Lee, Daniels, Puig, Newgent, and Nam (2008) studied the relationship between the background, psychological, and behavior variables of low SES students. Using 2,460 students from the National Educational Longitudinal survey, Lee et al. found “high school math scores were the most powerful predictor of post secondary educational attainment” (p. 306). Their study found the most prevalent indicators for educational attainment were low SES and low academic performance. Identifying the underlying cause of students who are performing below grade level, will help school personal to adapt the curriculum to suit their needs.

According to the Wisconsin Center for Education Research (WCER, 2007), Cognitively Guided Instruction (CGI) research indicated that “children come to school with rich informal systems of mathematical knowledge and problem solving strategies that can serve as a basis for learning mathematics with understanding” (p. 2). CGI teaches educators to building upon these informal learning experiences in a formal setting to understand the new ideas they are learning. According to Dutton and Dutton (1991), preschool programs teach children mathematical concepts with the use of manipulatives and allow the children to “explore” or play. These experiences provide a social context and the children appear to be playing, yet they are actually learning many mathematical concepts. These skills can include counting, patterns, and adding. As children enter kindergarten, this challenges teachers to build upon a student's prior knowledge in a formal classroom setting.

Educators should take environmental factors into consideration when planning instruction for students. The values, experiences, educational levels, and socioeconomic statuses play a factor with the child's educational instruction (Anderson, 2008). Hackman, Farah, and Meaney (2010) indicated a student's socioeconomic status does effect one's achievement. Early interventions are the keys to improving students' academic achievement. According to the National Center for Children in Poverty (2009), there are nearly 14 million children leaving in poverty, while 41% of children are live in low-income families. Research indicates that children living in poverty can face numerous challenges including academic difficulties, poor nutrition, and family stress (Anderson; Geoffroy, Cote, Giguere, Dionne, Zelazo, Tremblay, Boivin, & Seguin, 2010; Hackman, et al.).

Another environmental factor that may affect achievement is a child's family unit. Children may live in a household where the parents are non-English speakers or illiterate and are unable to assist the child with homework or skills in which they may be lacking. Some children may come from single parent household where the parent works multiple jobs to support the family. These environmental factors are important for an educator to know, so they can adapt the student's lessons to ensure they have the necessary skills to be successful.

In the first year of a child's educational experience, they will obtain the knowledge and skills that will help shape their future success in school (U.S. Department of Education, 2001). Educators should be aware of factors that may hinder the child's ability to perform certain tasks. A child's age may contribute to the student's inability to perform specific tasks that is not at their developmental level (Clanton, 2003). Another factor is a child's prior knowledge. Educators "need to understand the knowledge and skills children possess as they enter kindergarten and need to gain insight into how these develop across the kindergarten year" (U.S. Department of Education, 2001, p. v). According to Shellard (2004), teachers should create a learning environment which encompasses a variety of mathematical strategies to ensure a deep understanding of the concept. A child's home environment and SES may also have an impact on their instructional needs. Therefore, educators should provide students with guided instruction and guided practice when a new concept is introduced. This allows them to understand the skill prior to doing independent practice. Shellard found that students are likely to struggle in math if they are not provided with these opportunities. When educators are aware of the age, prior knowledge, and environmental factors that children have when entering kindergarten, they are able to adjust the lessons to provide developmentally appropriate instruction.

Multiple Intelligences and Learning Styles

Humans have preferred ways of thinking and processing information. Our brain chooses how to learn, process, store, and retrieve the data. Multiple intelligences and learning styles are two approaches in which people learn. According to Gardner (1983), multiple intelligence is a theoretical framework that focuses on an individual's intellectual strengths. While, Dunn and Dunn (1978) concentrated on one's learning style. A learning style differs from an intelligence. A learning style is the process of learning, including the approaches and ways people prefer to learn. Whereas, multiple intelligence is a way to demonstrate one's intellectual ability. Both multiple intelligences and learning styles are student-centered and support the change of tradition teaching methods.

Gardner

Gardner (1999) defined intelligence as a "biopsychological potential to process information that can be activated in a cultural setting to solve problems or create products that are of value in a culture" (pp. 33-34). Gardner (1983) believed there are eight criteria or signs of an intelligence. They include the potential isolation by brain damage, the existence of idiots, savants, prodigies, and other exceptional individuals, identifiable core operation or set of operations, a distinctive developmental history, evolutionary history and evolutionary plausibility, experimental psychological tasks, support from psychometric findings, and susceptibility to encoding in a symbolic system. Encompassed with these criteria, Gardner (1999) found people have a broad range of abilities and a weakness in one area, does not predict a weakness in another. These eight signs of intelligences are the criteria for which Gardner's multiple intelligences were created and can be judged.

Gardner (1983) found that children have preferred ways of thinking and processing information, thus he created seven distinctive multiple intelligences. They include: musical intelligence, bodily-kinesthetic intelligence, logical mathematical intelligence, linguistic intelligence, spatial intelligence, interpersonal intelligence, and intrapersonal intelligence. Musical intelligence is the awareness, appreciation, and use of sounds. One with musical intelligence recognizes tonal and rhythmic patterns, and shows the ability to perform and compose. A person with musical intelligences learns best through songs, sounds, and patterns. Gardner's next intelligence is bodily-kinesthetic. A bodily-kinesthetic leaner has manual dexterity, physical agility, and balance. They have a well-developed eye and body coordination. One with bodily-kinesthetic intelligence learns best through physical experiences and movement of the entire body or parts of their body. The next form of intelligence is the logical mathematical learner. Logical mathematical intelligence involves logical thinking, the ability to detect patterns, has scientific reasoning and deduction, the ability to analyze problems, and perform mathematical calculations. These learners desire to understand relationships and need tangible results. They are also able to understand the cause and effect relationship for manipulating numbers, quantities, and operations. The next intelligence is linguistic intelligence. Learners with linguistic intelligences enjoy words and language and display an ability to learn and effectively use words, whether spoken or written. Linguistic learners are able to use reading, writing, and storytelling to help acquire knowledge. Gardner identified spatial intelligence learners show visual and spatial perception. They are able to understand relationships between images and meaning. Spatial intelligence learners show the ability to mentally visualize the manipulating of objects. This can include reading maps, charts, mazes, and puzzles to obtain and retain information. Another form of intelligences is interpersonal intelligence. This involves learners working effectively together. Interpersonal learners have the ability to relate to other's feeling and body language. Gardner found intrapersonal learners have self-awareness and prefer to work by themselves. They are considered to be introverts. Subsequent research found three other intelligences: naturalist intelligence, spiritual intelligence, and existential intelligence. The naturalists are learners who enjoy nature and the world around us. The spiritual intelligent learner relates to spirituality and religiosity. The existential intelligent learners ponder ultimate issues, such as life and death. Gardner feels these independent, well-defined intelligences work together and educators should plan instruction based on the intelligences of the learners.

Applying these ideas into the realm of education can be a difficult task for educators. However, studies show implementing Gardner's multiple intelligences promotes intellectual productivity (Formisano, 2008; Kaya, Dogan, Gokcek, Kilic, Z., & Kilic, E). Kaya et al. studies 60 eighth grade students to determine if implementing teaching strategies derived from Gardner's multiple intelligences would increase student's achievement and attitude towards science. Students were given the Armstrong Multiple Intelligence survey to determine their strengths and weaknesses. The results were used to develop and guide instruction. This study found a connection between Gardner's multiple intelligences and students' academic achievement and attitude towards science. The theory behind multiple intelligences is to emphasize child-centered learning to enhance each child's unique set of intelligences (Formisano). "Teachers [should], individually and collectively, ground practice in beliefs, assumptions, and understanding of the purposes of schools, the ways in which children learn and their sense through study and practice of effective instructional strategies" (Formisano, p. 1). When teachers are armed with the knowledge and tools to implement Gardner's multiple intelligences into a classroom, they can successfully reach a wide range of ability levels, while promoting intellectual productivity.

Gardner (1983) understands that putting these theories into practice may be a challenge. However, Gardner's multiple intelligences have had a profound impact on the way educators think and practice. Studies show implementing Gardner's multiple intelligence will increase student achievement (Douglas, Burton, Reese-Durham, 2008; Formisano, 2008; Kaya et al, 2007). Implementing Gardner's (1983) theory into practice involves "matching the individual learner's profile to the materials and modes of instruction" (p. 390). This will enable a learner to reach their optimal learning potential.

Dunn and Dunn

Educators are aware that all children learn differently. Dunn and Dunn (1978) found several factors that can inhibit a student's learning. Dunn and Dunn's most notable accomplishment is discovering everyone has a specific learning style and learns best through this method. This learning style is the way in which each learner begins to concentrate on, process, absorb, and retain new and difficult information.

Dunn and Dunn (1986) found several elements that educators should take into consideration when creating a suitable learning environment and instructional strategies. According to Dunn and Dunn, ones' learning style is affected by the environment, emotional and sociological needs, psychological, and physical characteristics when learning a new concept. In order for students to be successful, educators should take these factors and strengths into account when creating classroom environments and planning instruction.

Dunn and Dunn (1986) are most known for four distinctive perceptual strengths for processing information using visual, auditory, tactual, and kinesthetic means. Visual learners process their information primarily though sight. The auditory learner thrives on information that is taught through sound: hearing, thinking, and speaking. While a tactual learner prefers to learn by touching, manipulating, and handling objects. The final modality is a kinesthetic learner. The kinesthetic learner prefers to learn through physical means. These students enjoy actively participating in an exercise or form of movement to learn new material. Dunn and Dunn believe everyone has a specific perceptual strength. They found students learn best through their preferred learning style. It is important to note that some students use a combination of their senses to learn. These students should be taught through a multisensory approach. Implementing these modalities into every lesson will ensure the needs of all students are being met.

When educators implement Dunn and Dunn's learning styles into their classrooms, there is an increase in achievement (Bozkurt & Aydogdu, 2009; Kinshuk, Liu, & Graf, 2009; Mitchell, 2009). Kinshuk et al. conducted research on the correlation between student achievement and learning styles. They investigated how students would handle taking a course that was mismatched with their primary learning style. Kinshuk et al. used the Index of Learning Styles questionnaire to determine the preferred learning method of 72 college students. The results indicated students with strong preferences for a particular learning style had more difficulties learning when in a course that was mismatched with their preferred learning style. Thus impacting their academic success. Dunn, Dunn, and Perrin (1994) found, "when students were introduced to new material through their perceptual preferences, they remembered significantly more than when they were introduced through their least preferred modality" (p. 16). A student's learning potential is guided by their learning style.

Mitchell (2009) implemented the learning style model into multicultural learning environments. The results showed an increase of achievement levels and motivation. A student's motivation is based in their interest and ability to lean the material. If a student feels a concept is too difficult, they may not try. Whereas, a student that is interested in a topic, may try harder to succeed. Dunn and Dunn (1978) found students motivation can be reversed if they are taught through their preferred learning style and at their appropriate academic level.

Bozkurt and Aydogdu (2009) compared traditional teaching methods to Dunn and Dunn's multisensory approach to learning. The research was conducted with 61 sixth grade science students over an 8-week time period. This study revealed a significant impact on achievement scores when students were taught using a multisensory approach.

Gardner (1983) and Dunn and Dunn (1978) have made significant contributions to the field of education. Studies show when implementing these concepts into the classroom, there is an increase in student achievement (Bozkurt & Aydogdu, 2009; Formisano, 2008; Kaya et al, 2007; Kinshuk et al., 2009; Mitchell, 2009). This challenges teachers to create lessons that contain a variety of learning styles and multiple intelligences to ensure all students' needs are being met.

Academic Achievement

Educators are searching for programs and strategies to improve students' academic achievement. In order for teachers to implement new strategies, they should know how the brain works and ways to help stimulate the brain for learning to occur. It is also important for educators to know how to help children store the new knowledge into their long-term memory.

According to the U. S. Department of Education (2007), children's cognitive abilities are thought to be the core ingredients for success in school.

> Current research on the neural network of the brain suggests that each learning experience created a specific pattern of neuronal circuit firing. The more the pattern has been stimulated, or fired in the past, the higher the probability of future activation. Thus, a child who experiences high practice rates and high success rates (taught correctly, errors are immediately identified and corrected) with manipulation of numbers is mathematically advantaged over a child who, with equal neuronal integrity, practiced math less after and with more undetected errors. (Augustyniak, Murphy, & Phillips, 2005, p. 278)

Sousa (2006) found presenting information in a sequential format will help stimulate the brain for learning to occur. The sequence will stimulate the neutral network in the brain to help in student achievement. First, it is important to relate the new information to a child's prior knowledge. Next, the child should practice the new information, through hands-on methods. Repetition of the learning experience and identifying the relevance will spark the neutral network in the brain. This will enable retrieval of the information to occur. Finally, teachers should ask and discuss how the child will use the new information. This will allow the child to identify its relevance and help store the information into their memory.

Willis (2005) found repetition is key to improving out working memory. This allows teachers to use multiple pathways to connect material and activate the neurons in a student's brain. The more times the action is repeated, through practice, the greater chance the brain will retrieve the information at a later time.

Important factors in academic success include the development of our memory and the ability to learn (Nobel, Tottenham, & Casey, 2005). Learning and memory involves the hippocampus, which is located in the temporal lobe of the brain. Studies show to help stimulate the brain of young children and store new information, hands-on manipulation should be used. The use of hands-on materials will increase one's sensory input and help a child attend to the task. Sousa (2006) also found, children can feel overwhelmed when learning new information. The content should be taught in small steps with many opportunities to practice the information. Teachers should also create lessons which are presented using multiple modalities to increase student's academic achievement (Bullock, 2005).

When educators know how to stimulate the brain and help children retain the information into their memory, academic success can occur. Creating lessons that have a sequential format, multimodalities, which includes plenty of hands-on practice, will enable children to be successful at the given task. The ability for a student to store, retrieve, and apply the learned tasks can be a combination for success.

Mathematics Instruction

Educators are searching for effective instructional methods to improve students' mathematical abilities. There are several mathematical concepts that students should acquire to have a firm foundation in order to build upon more complex ideas and concepts (Fuchs, Powell, Seethaler, Fuchs, Hamlett, Cirino, & Fletcher, 2010; WCER, 2007). Studies show the use of manipulatives is essential for student success (Fan & Bains, 2008; Nelson, Sassi, 2007). Class discussions are also an important instructional tool. Dialogue between peers, which involves mathematical language and the multiple ways to solve problems, can increase students' mathematical thinking and reasoning (WCER).

Students who have difficulties understanding and retaining basic mathematical concepts will likely place those students at risk for math difficulties (Vinson, 2001; Dervarics, 2009). According to Burns and Silbey (2000), the term "basics" has a variety of definitions. They can include addition, subtraction, multiplication, and division, depending of a child's grade level. However, "applying computation skills to solve problems and develop good number sense are both essential ingredients of what's basic to children's math learning" (Burns & Silbey, p. 43). Students should not simply memorize these basic concepts, they should understand and be able to apply the concept in multiple situations. Early mathematical skills are the foundation for more complex mathematical skills and reasoning. Fuchs et al. (2010) found proper remediation of these deficits are key to a student's success.

In order for students to be successful mathematicians, they should have effective instruction (Bottge, Rueda, & Skivington, 2006). Fan and Bains (2008) researched 3,147 kindergarten students in 200 schools to determine if effective instruction and an increase of instructional time will improve student achievement. Using math games, music and movement, class discussion, collaboration, solving real-life math problems, and group work were identified as effective instructional methods. These instructional methods are also important to use with gifted students. According to Rayneri, Gerber, and Wiley (2006), gifted students should also participate in hands-on and real-world problems to help them remain motivated and engage in the learning process. Fan and Bains found kindergarten teachers can promote instruction with the use of a variety of activities. Studies show increasing instructional time, with the use of a variety of instructional methods, will increase students' mathematical achievement and understanding (Fan & Baines; Derringer, 2007).

The use of manipulatives are vital when teaching mathematical concepts to students in kindergarten through second grade (Wallace et al., 2007). Manipulatives are appealing to children; from colorful teddy bear counters to Cuisenaire rods. The use of manipulatives enable children to see abstract ideas in a concrete manner. Manipulatives allow children to physically touch and manipulate the materials in order to come up with the correct solution to an abstract concept (Burns & Silbey, 2000). Once children are able to fully understand the abstract concept with manpulatives, they will be able to apply it to paper and pencil activities.

Nelson and Sassi (2007) found many teachers and principals assume students know basic math facts. However, this is not always the case. Nelson and Sassi worked with almost 100 elementary schools in urban, rural, and suburban schools. Observing in classrooms and speaking with teachers and principals, they found key elements to increase a student's conceptual understanding. To increase a students' conceptual understanding, the use of manipulatives, asking open-ended questions, and small group instruction are key (Nelson & Sassi).

Class discussions or "math talks" are an important part of math instruction. According to Burns and Silbey (2000), class discussions provide students opportunities to "share their knowledge, raise questions, try out new ideas, get feedback on their thinking-from classmates as well as from the teacher-and hear other points of view" (p. 33). De Garcia (2011) found math talks enable students to reveal an understanding of the concept, gain deeper reasoning, explain and justify a solution, while supporting learning and improving ones memory. When children are taught a variety of strategies and given opportunities to hear other's thought process, they have deeper discussions, evaluate their learning, and try a variety of learning strategies. Thus, math talks can increase student engagement and develop a deeper understanding of mathematical concepts (De Garcia).

Burns and Silbey (2000) found the importance of communicating their ideas through social interactions was a crucial component for learning. In order to for students to communicate their ideas effectively through math talks, it is important to create an environment that allows the students to feel comfortable, supported, and accepted to share their ideas. Teachers should begin by demonstrating how to explain their solutions and reasoning, ask appropriate questions, and support their classmates. Small group discussions can be less threatening for students and they may be willing to take chances. Kindergarten students are able to construct an understanding and invent ways to solve mathematical problems through exploratory math talks (Burns and Silbey).CGI students are challenged to find their own solutions without explicit instruction and are required to explain and justify their solution with classmates and the teacher (WCER, 2007). Teachers are able to listen to the dialoged amongst the students, providing feedback or support if needed.

Ogu and Schmidt (2009) conducted their research during a science project on rocks. Their research found it is essential for teachers to ask questions. Taking an inquiry based approach, Ogu and Schmidt, establish asking open ended questions, where there is not right or wrong answer, fosters a higher level of thinking and discussions.

Math talks and class discussions can help students obtain a deeper understanding of mathematical concepts. Using manipulatives when teaching mathematical concepts should enable students to learn abstract concepts. Creating a learning environment in which children feel comfortable and secure to discuss their mathematical findings, will encourage children to try new methods and hear other's thought process, which will increase their mathematical knowledge.

The TouchMath Program

The TouchMath program was developed by Bullock (1975), who was an elementary school teacher. The mission of the TouchMath program has evolved from a focus on children with learning disabilities to producing programs for children of different aptitudes, learning styles, and cultures. In just over 30 years, TouchMath is found in classrooms in all 50 states and also internationally.

The TouchMath program is a comprehensive program to teach counting, addition, subtraction, multiplication, division, story problems, time, money, and fractions (Bullock, 2005). Using the TouchMath program, children as young as 4 and 5-years-old are able to accelerate their comprehension abilities in mathematics. This is done by students interacting with numbers on paper by seeing, saying, hearing, and touching the numbers. Children are able to solve mathematical equations and arrive at the correct answers without guessing or the use of manipulatives. This program has a multisensory approach to teaching math. Each number has a TouchPoint or dot (see Appendix D). TouchPoints are strategically located on numbers one through nine. Numbers one through five use single TouchPoints. Numbers six through nine use double TouchPoints symbolized by a dot inside of a circle. Children learn where the TouchPoints are on each number. The students begin learning the TouchPoints by visually looking at the TouchPoints and physically touching them on each number.

The TouchMath program is a multisensory, teacher-friendly approach to teach students skills from basic addition to complex division. The program includes five kits that are designed to be taught sequentially; each providing the teacher and students with complete resources and activities for the designated math skills (Bullock, 2005). The students begin with activities to teach the locations of the TouchPoints on the numerals. Once students memorize the TouchPoint locations and patterns, they are able to move onto the addition series. This begins with the TouchPoints on the numerals and students are taught a counting-all strategy. This is where the student counts all of the TouchPoints to obtain the correct solution. Once the students have mastered the count-all strategy, students are taught the counting-on strategy. Once students have mastered these skills, the TouchPoints are slowly removed from the numerals. It is important to note, even though the TouchPoints are removed, students are able to use their pencil to touch the numbers or draw the TouchPoints on the numbers, if they are unsure about their answer. The program progresses through these set sequences to allow the students to understand the mathematical concepts and move onto more complex skills.

The TouchMath program has developmentally appropriate teachings of mathematical concepts which include modeling, guided practice, and plenty of independent practice. This enables teachers to provide students with multiple learning opportunities and experiences. The program's repetition will allow students to acquire a clear understanding and application of the concepts. The TouchMath program begins with the foundation of mathematics and progresses through more complex skills and concepts. Using this program, teachers can provide students with the tools needed to become successful math students.

The TouchMath program takes the constructivist approach to teaching and learning and incorporates many educational researchers' concepts and theories into the program. Piaget (1966; 1975) and Bruner's (1966) stages of development provide the teacher with a framework of where students are developmentally and ways to teach them. The TouchMath program is multimodal and incorporates Gardner's (1983) multiple intelligences and Dunn and Dunn's (1975) learning styles into the program.

According to Piaget's (1975) stages of development, most kindergarteners are in the preoperational stage of development. Therefore, when performing mathematical operations, educators should provide students with manipulatives. However, some students are beginning to move between the preoperational and concrete stage of development. Consequently, educators should provide these students with a combination of learning experiences. When children explore addition in the preoperational stage of development, manipulatives or pictures are used on the numerals to represent the TouchPoints to enable children to count and add the quantity accurately. This allows children to use their counting skills to add two or more numbers. This should be done on a repeated basis until the brain assimilates each numerical concept (Bullock, 2005). For students who are at or moving toward the concrete stage of development, the pictures and manipulatives are removed from the numbers and the child can use the TouchPoints.

When learning a mathematical concept, students need to internalize ideas using methods that are meaningful to them. Using Bruner's (1966) stages of development, they are able to get a better understanding of the concept being taught. It is important for students to learn to use sources other than memory, symbols, and numerals in mathematics. Our memory is not always reliable and numerals and symbols are at the high end of mathematical operations (Bullock, 2005). Using the TouchMath program, students can move through Bruner's developmental stage at their own pace and order necessary for development. This process may begin by using objects and placing them on the numerals representing the TouchPoints in the concrete stage of development. In the pictorial stage, TouchPoints or dots are located on the numbers. TouchMath helps students focus on the numeral by providing them with the pictorial representation of how many, as well as the symbol. The symbolic stage uses the numeral to symbolize that amount. According to Bullock, this methodology helps build a bridge between concrete and abstract thinking.

The TouchMath program also incorporates Vygotsky's (1986) zone of proximal development into the program. This enables students to perform tasks with assistance that they would not be able to perform independently (Kermani & Brenner, 2000). This will in turn increase their cognitive development. Smith (1998) emphasizes, "Teachers must help children construct and elaborate upon what they already know, so they can 're-invent' mathematics for themselves. A reflective teacher helps the child discover and communicate ideas that would not have occurred spontaneously without the adult's help" (p. 7). Vygotsky also found children learn and develop through social interactions. Math instruction should focus more on the process than on the computation and using only one method to solve a problem. The TouchMath program incorporates these concepts by allowing students to share their thought processes and justify their answers (Bullock, 2005). Students are able to learn from others by listening to the methods they used to solve the mathematical equation. According to Draper (2002), teachers should deemphasize rote memorization of isolated skills and facts, and emphasize problem solving and communication, whereby students can gain mathematical power.

Guarino, Hamilton, and Lockwood's (2006), study included over 16,000 kindergarten students in 944 private and public schools in the United States. Their research involved instructional practices and teacher characteristics related to student achievement. They researched both language arts and mathematical achievement gains. In mathematics, they focused heavily on number sense, properties, and operation, such as counting and addition using pictures. This study found “a meta-analysis of studies including kindergarten research found that the use of concrete materials or manipulatives, compared with more abstract instruction, was related to improved achievement and attitudes toward mathematics” (Guarino et al, 2006, p. 4). They also indicated when teachers provide student centered math activities and having students explain how the problem was solved will enhance student achievement.

The TouchMath program uses many of the strategies set forth in Guarino, Hamilton, and Lockwood (2006) study. They introduce children to mathematical concepts through hands-on activities involving the manipulation of concrete objects. Once the students have mastered computations with manipulatives, they are given pencil and paper activities where they are able to use the TouchPoints to solve the mathematical equations (Bullock, 2005). Teaching students the TouchPoints will allow them to have a manipulative in front of them at all times to solve mathematical equations. The primary purpose of the TouchMath program is to provide age appropriate mathematical instruction, to primary school children. Providing children with developmentally appropriate math instruction can make a positive influence on students’ learning. The TouchMath program stresses both the understanding and the application of mathematical concepts.

The TouchMath program can be adapted to suit Howard Gardner’s theory of multiple intelligences (Allix, 2000). The bodily-kinesthetic learner needs to learn though physical means. Students are able to physically place objects on the number to represent the TouchPoints. The interpersonal child enjoys interacting with others. This child can be a helper or tutor a less capable learner. The logical-mathematical intelligent child will enjoy the TouchMath program because it focuses on mathematical concepts. Spatial intelligent children are visual learners. TouchMath is visually appealing because of the pictures on the numerals. Children with linguistic intelligences benefit from speaking, listening to, and writing the computations. The naturalistic child enjoys the outdoors and nature. These children can glue on leaves or acorns to represent the TouchPoints. Musical intelligence children enjoy the rhythmic patterns and chanting. These students can tap the number of TouchPoints using their pencil to calculate the mathematical equation (Allix). These are several examples of how one can employ Gardner's multiple intelligences with the TouchMath program.

The National Council of Teachers of Mathematics addresses "equity" as their first principle for school mathematics ([NCTM]; 2006). Mathematics education requires high expectations and support for all students. Teachers should accommodate differences to help all students learn (NCTM). Along with the NCTM, many states, including Georgia, have adopted the Common Core State Standards Initiative (2010). The Common Core State Standards Initiative was designed to provide students with a sold mathematical foundation which stress not only the procedural skill, but a conceptual knowledge taught through modeling and hands-on methods. For these reasons, it is important for teachers of mathematics to present the skills or concepts they are teaching in different modalities to ensure all children understand the concept. Bedard (2002) found math teachers should plan lessons that are multimodal to ensure all students are learning. The TouchMath program incorporates Dunn and Dunn's learning styles. It appeals to children through auditory, tactile, kinesthetic, and visual means. TouchMath provides visual clues, such as TouchPoints and objects on the numerals to help the student visualize the concept. The TouchMath program allows auditory learners to verbalize the steps needed to compute a mathematical equation. Tactile children are able to count the TouchPoints by physically touching them. Kinesthetic learners can use the foam numbers on the carpet moving around to place the TouchPoints on the numbers. When educators incorporate these modalities into their lessons, it allows the students to determine which approach works best for their learning style and assist them in becoming successful math students. "Activities that provide opportunities for students to use a variety of learning styles increase the likelihood that more students will understand the new concept or skill being presented" (Shellard, 2004, p. 41). TouchMath provides students with instruction in all four modalities to reinforce the information being processed (Smith, 1993). Allix (2000) found creating lessons that use an array of learning styles will allow teachers to meet the needs of all of their students.

With the TouchMath program, students explore the TouchPoint with manipulatives and then the numbers actually become the manipulative. The TouchMath program will allow students to have high success rates when calculating addition problems. They will be able to easily check their answers and identify incorrect answers. If an answer is incorrect, students can use the TouchPoint as their manipulative to solve the problems successfully. The TouchMath program offers comprehensive steps that children are able to easily follow when solving mathematical equations (Bullock, 2005). According to Shellard (2004), "A critical component of math instruction–particularly crucial for struggling students–is ensuring that all students understand a skill or concept before being asked to practice it" (p. 41). Children should be given many opportunities to practice these strategies, which will provide students the confidence they need when computing mathematical equations (Shellard). The TouchMath provides students with plenty of modeling, guided practice, and independent practice. This enables teachers to provide students with multiple learning opportunities and experiences to ensure mastery.

Prior Research

The review of the literature revealed a limited number of studies on the TouchMath program that have a large number of participants in a regular education classroom. Most studies are conducted over a brief period of time (Jarrett & Vinson, 2005; Newman, 1994; Scott, 1993). Several studies on the TouchMath program were done with students with disabilities in self-contained classrooms, which have a limited number of participants (Scott; Newman). Other studies have a large number of participants in a regular educational setting, but are done over a short period of time (Jarrett & Vinson).

Scott (1993) researched the TouchMath program to determine if it would improve addition and subtraction skills of students with mild learning disabilities. The study was done with three students over a period of 20 sessions. Each student received individual daily instruction that lasted 15-30 minutes. Scott began by introducing the TouchPoints to the students. Once they mastered the locations of the TouchPoints, the students were then taught the addition and subtraction skills. After the study was concluded, Scott conducted a follow-up assessment over the summer to determine the reliability of the study. Scott's results showed that the TouchMath program increased the students' computation abilities.

Jarrett and Vinson (2005) based their research on whether the TouchMath program contributes to students' overall mathematical achievements. The researchers randomly chose high-performing elementary schools based on standardized test scores. The study involved 110 first grade students from six self-contained classrooms. The purpose of this study was to determine if a group of first grade students, who were taught the TouchMath program, would show a higher mathematical achievement when solving addition problems than those who were taught through traditional teaching methods. This study was conducted for 45-minutes a day over a one-week time period. The results of Jarrett and Vinson's research showed that the students' computation abilities increased during the week of instruction.

The study conducted by Newman (1994), examined the effectiveness of the TouchMath addition program with four Down Syndrome students. The student's ages ranged from 8-year-olds to 11-year-olds. The students were able to rote count to 50, perform one-to-one correspondence to 50, and able to recognize and identify numbers to 20 prior to beginning the research. The students were taught the location of the TouchPoints and the counting-all strategy. Once the students mastered these skills, Newman faded away the TouchPoints on the numerals. The sessions were conducted four days a week and lasted 20 to 40 minutes. The results showed the TouchMath program improved the addition abilities of the four participants.

Much of the prior research relates to the skills and strategies that are incorporated into the TouchMath program. Bruner (1966) and Piaget (1966) have theories that are similar to the philosophy of TouchMath in that sequential learning strategies are applied and as a result students learn mathematical skills more effectively and improve at a quicker rate. However, the research studies are lacking the longevity and population. This indicates a limitation to their study. Scott (1993) and Newman's (1994) research was lacking a large number of participants. Scott has three participates and Newman had four students participate in the study. It is important to note that Jarrett and Vinson (2005) conducted their study over a one-week time period. This is not a sufficient amount of time to truly determine if the TouchMath program contributed to the increase in test scores. The students had only one week to learn all of the TouchPoints and apply them to solve the addition problems. Further research is needed to determine if the TouchMath program improves students' computation abilities.

Summary and Transition Statement

With a decrease in mathematical achievement in Georgia schools and accountably in NCLB, the curriculum is moving away from the constructivist paragon. "Educators are under tremendous pressure to increase the academic performance of all students, especially in the areas of reading and mathematics" (Witzel & Riccomini, 2007, p. 13). Lewis (2007) found almost 3.4 million high achieving students from low income families are underserved. Politicians believe educators should develop high standards to which all students will be helped; align the curriculum to these standards; construct assessments to measure whether all students are meeting the standards; reward schools whose students meet the standards, and punish schools whose students do not (Brooks & Brooks, 2001). This view point depends upon the assumption that every student has the same background knowledge, cognitive stage of development, and learning style, which is not the case. Learning is a complex process and all children learn differently. Adapting lessons to suit the needs of each individual child in order for them to be successful learners are key to academic success.

Young children are natural learners. They bring informal mathematics knowledge and experiences to the classroom. Children are continually constructing mathematical ideas and concepts. “Providing hands-on, mind-on, relevant learning experiences in both science and mathematics can fuel a student’s learning” (Gallenstein, 2005, p. 127). Studies show when educators take a proactive role in encouraging students to become excited about mathematics and see themselves as successful, confident, mathematicians (WCER, 2007). Smith (1998) found key ingredients for a student’s academic success. They include: “a well-prepared environment, a developmentally appropriate math curriculum, and an awareness of the teacher’s role” (Smith, 1998, p.10). The TouchMath program will help educators use these ingredients to improve their instruction and student academic achievement in mathematics.

Children who did not master early mathematical skills struggled when introduced to more complex skills (Vanderheyden & Burns, 2007). Students, who can think, understand, and reason mathematically will be able to use what they have learned to solve problems, both in and out of school. The TouchMath program builds a firm foundation and speeds up student achievement (Bullock, 2005). To achieve this, instruction should be directed toward the students' developmental level. According to Shellard (2004), "students do not discover or understand mathematical concepts simply by manipulating concrete materials…[teachers] must help students focus on the underlying mathematical ideas" (p. 41). The TouchMath program provides students with developmentally appropriate practices and incorporates many psychological and educational approaches endorsed by Bruner (1966), Piaget (1966), and Vygotsky (1986).

Using the TouchMath program, children as young as 4 and 5 years old are able to accelerate their comprehension abilities in mathematics (Bullock, 2005). The primary purpose of the TouchMath program is to provide age appropriate mathematical instruction to primary school children. Providing children with developmentally appropriate math instruction can make a positive influence on students' learning. The TouchMath program stresses both the understanding and the application of mathematical concepts (Bullock). "In studies predicting future academic achievement from skills measured in kindergarten screenings, research has suggested that mathematic performance is predicted by a more complex set of skills than is reading performance" (Augustyniak, Murphy, & Phillips, 2005, p. 277). The TouchMath program begins with a solid foundation. The students learn the TouchPoints on the numerals and progress through more complex concepts and skills. Teachers select mathematical tasks that appeal to their students' interests and intellect. This model is designed to improve students' mathematical abilities.

The TouchMath program is found to have developmentally appropriate teaching strategies and has shown to improve students' computation abilities (Bullock, 2005;

Jarrett & Vinson, 2005; Newman, 1994; Scott, 1993). Research indicates the TouchMath program has developmentally appropriate instructional strategies that coincide with the theories of constructivism. Piaget (1966) and Bruner's (1966) created stages of development that are a useful instrument for educators. These stages of development allow educators to meet the needs of each student at their developmental level. Vygotsky's ZPD will assist students to obtain cognitive growth and encourage independence. The TouchMath program takes these strategies into consideration and developed instruction to suit the needs of all learners. Implementing these strategies into the classroom environment, will provide students with effective instruction that will improve academic achievement.

The TouchMath program also takes a student's preferred learning style and how they learn into account using Gardner's (1993) multiple intelligences and Dunn and Dunn's (1978) learning styles. This provides educators with the tools needed to tailor their instruction based on the learning styles and multiple intelligences of their students to increase their learning potential (Jarrett & Vinson, 2005; Newman, 1994; Scott, 1993).

All across the country, there is a great deal of emphasis on standardized tests. During these high stakes tests, students are not able to use manipulatives. Research shows that using the TouchMath program improves students' computation abilities and accelerates student learning (Jarrett & Vinson, 2005; Newman, 1994; Scott, 1993). TouchMath is a concrete means of solving addition problems that does not rely on memorization of facts or require the use of physical manipulatives, such as fingers or counters. Thus, students are able to have the manipulative in front of them at all times;

the manipulative is the number. This allows them to answer the mathematical equation accurately and advance with their mathematical skills at a quicker rate.

Section 3 is an explanation of the research study. Section 4 is a presentation of the quantitative data and analysis of the research study. A summary of the findings and recommendations for further research are presented in section 5.

Section 3: Methodology

Introduction

There is a concern among educators regarding the mathematical achievement of students at ABC Elementary School, in Northeast, Georgia. Data obtained from state mandated tests, such as the Georgia Criterion Referenced Competency Test (CRCT), indicated that there is a 55% increase in the number of students who did not meet the minimal requirements for the 2004-2005 and 2005-2006 school years on the first grade mathematics section (U.S. Department of Education, 2007). The data gave cause for investigation. These deficits in math achievement, coupled with the stricter educational requirements and standards established by NCLB, are a concern to educators at ABC Elementary School. As a result, teachers are looking for mathematical programs to increase student achievement.

The purpose of this study was to evaluate the effectiveness of the TouchMath program on the computation abilities of a group of kindergarten students at ABC Elementary School in a northeastern suburb of Atlanta, Georgia. This study was conducted to answer the question:

Is there a difference in computational abilities between kindergarten students taught by the TouchMath program and those taught through traditional means?

H_0: There is no significant difference in math scores for kindergarten students who are exposed to the TouchMath program compared to those who are taught through traditional means.

H_1: There is a significant difference in math scores for kindergarten students who are exposed to the TouchMath program compared to those who are taught through traditional means. These hypotheses were designed to assess the growth of kindergarten students' math achievement using the Harcourt (2004) math assessment.

I determined students who used the TouchMath program demonstrate a higher level of performance on the Harcourt (2004) chapter posttest when compared to students who were taught through traditional methods.

Using a quasi-experimental nonequivalent control-group design, the groups were convenience samples based on the naturally formed groups (Creswell, 2003). Using six kindergarten classes at ABC Elementary School, I investigated whether there was a difference between the TouchMath program and traditional mathematical teachings as it related to students' computation abilities. Three classes were taught the TouchMath program and three classes were taught through traditional teaching methods. The baseline archival data for this quantitative study came from the Harcourt (2004) chapter pretest. Over a 6-week time period, the students received math instruction, as part of the regular school curriculum. At the end of the 6-weeks, the participants took the Harcourt posttest. Using a *t* test, an analysis of the pretest against the posttest determined if there was any statistical significance.

Research Design and Approach

The quantitative design was a quasi-experimental nonequivalent control-group design. Quantitative studies measure these outcomes through statistical means to show relationships, correlations, and cause and effect relationships (Creswell, 2003).

Qualitative methods measure individual and group interactions in a setting, and explore answers to how and what questions (Merriam & Associates, 2002). According to Creswell (2003), qualitative research methods should be employed when the researcher is unsure of the variables to study, the issue is new, or the topic has not been explored for a certain population. Quantitative research methods should be used when the researcher needs to predict outcomes or compare interventions. I was searching to determine if there was a correlation between the TouchMath program and traditional mathematical teachings using pre and posttest scores. Therefore, a quantitative study was chosen for this study.

This study was conducted in six kindergarten classrooms at ABC Elementary School in northeast Georgia. The quasi-experimental design was chosen rather than a true experimental design due to the naturally formed classrooms (Gliner & Morgan, 2000). A quasi-experimental design uses pre-existing groups rather than random assignment of groups. Montero and Leon (2007) explained that quasi-experimental studies as those that "include intervention designs applied in natural settings where it is not possible to make random assignment or to control the order in which the tasks are presented" (p. 6). While, Gliner and Morgan described a quasi-experimental nonequivalent control-group design as an elementary school setting, with an independent variable. The environment may consist of naturally formed classrooms where the teacher is not able to randomly assign students to a certain group. A quasi-experimental design was appropriate for this research because, "in quasi-experiments, the investigator uses control and experimental groups but does not randomly assign participants to groups (e.g., they may be intact groups available to the researcher)" (Creswell, 2003, p. 167). This methodology was chosen because it is not possible to randomly assign the groups and systematically assign individuals to receive the treatment due to the naturally formed classrooms.

The rationale for choosing the nonequivalent, pre and posttest design was to compare and analyze the effects of two different instructional methods. The nonequivalent group design included an experimental, treatment group, and a control group structure using a pre and posttest design without using a random sample (Montero & Leon, 2007). A quasi-experimental quantitative method enables the researcher to "test the impact of a treatment (or an intervention) on an outcome, controlling for all other factors that might influence that outcome" (Creswell, 2003, p. 154). I investigated the theory of constructivism as it relates to the TouchMath program to determine if there was a relationship between student achievement when compared to students who were taught through traditional methods. The quasi-experimental nonequivalent control-group design is represented in Figure 1 (Creswell).

Group A O ——— X ——— O

Group B O ——————— O

*Figure 1. Q*uasi-experimental nonequivalent control-group design

Group A is the experimental (the students who are taught using the TouchMath program) group. Group B is the control group (the students who are taught using traditional teaching methods). The X represents the students who used the TouchMath program and the O represents the pre and posttests.

According to Creswell (2003), in a quasi-experimental design, the experimental and control groups are selected without random assignment. While only the experimental group receives the treatment, both groups take the pre and posttest. Group A was the experimental group and received the treatment (the students who will use the TouchMath program). The control group, or group B, did not receive the treatment (the students who were taught using traditional mathematical teaching methods). Both groups took pre and posttests, which are indicated by the O's. The X represents the students who were taught the TouchMath program.

I examined the theories of constructivism by comparing the effectiveness of the TouchMath program on the Harcourt (2004) Math Assessment Guide. Group A, the experimental group, received the treatment (the student group who used the TouchMath program), while Group B, the control group; were taught using traditional math instruction. The teachers who provided the TouchMath instruction also implemented the teaching strategies discussed in the review of literature section. This ensured the students received the TouchMath program's constructivist approach to learning. Both groups took a pre and posttest (Appendix A). A discussion of the teaching strategies will follow in a consequent part of this section.

Setting and Sample

This study took place in a large suburban elementary school located in northeast, Atlanta, Georgia. The county is the largest school system in Georgia and has approximately 157,638 students in kindergarten through twelfth grade (National Center, 2007). Sixty-nine of the 114 schools in the county are elementary schools. Data retrieved from the National Center for Education Statistics (NCES) showed there are 1,127 students at ABC Elementary School (2007). The kindergarten through fifth grade student body consists of 580 male students and 508 female students. The student body comprises 538 European Americans, 248 African Americans, 181 Hispanics Americans, 125 Asian Americans, and 1 Native American student. Twenty-seven percent of the students receive free or reduced lunch services (NCES, 2007). There are nine kindergarten classes at ABC Elementary School and each class has 16 or 17 students.

On September 28, 2009, during a grade level meeting, six teachers were asked to participate in this study based on their willingness, interest, and instructional expertise. Three of the teachers have used and are currently using the TouchMath program in their classrooms, while the three other teachers have not used the program. The teachers that administered the TouchMath program have used the program for at least 3 years. All of the teachers participating in the study have taught kindergarten for a minimum of 8 years and all hold master's degrees in related fields.

This quantitative study used a convenience sample experiment. The student participants were selected in accordance with the school's entrance data and the software program *Elementary Class Assigner* by MacKinney Systems, Inc. The student participants for this study were chosen from a pool of 120 students registered for kindergarten at ABC Elementary School in northeastern Georgia. The sample for this study included six kindergarten classes. The participants included 100 students from six kindergarten classrooms. Each class had 16 or 17 students. Participants were assigned to their respective kindergarten classrooms based on enrollment data. A nonprobability sample was determined by utilizing enrollment data and class selection data maintained by the admissions office of the research school, to compile the population of these classes. The predetermination of classes does not involve random selection therefore validating the convenience sample and the non-probability sample of the participants. Single-stage sampling enrolled 50 students in the experimental group and 50 students in the control group for this study. Three classrooms represented the experimental group and three classrooms represented the control group. All participants were divided evenly in terms of age, gender, and entrance data. The participants in the study included a mix of male and female students from a variety of ethnic and socioeconomic backgrounds.

All of the participants turned 5 years old by September 1, 2005 to be eligible to attend kindergarten in Georgia. There were five students who will be repeating kindergarten and two who had an individual educational plan (IEP). The number of English language learners (ELL) students included 24 in the experimental group and 22 in the control group.

With a kindergarten population of approximately 120 students in nine classes, a sample size of 100 participants in six classes allowed me to examine the sample and generalize the results of the entire population (Gravetter & Wallnau, 2005). The experimental and control groups both had approximately 50 students. The participants were chosen without random assignment.

Treatment

Treatment for this study included traditional mathematical methods and the TouchMath program. Baseline archival data for the study came from the Harcourt (2004) assessment, which contains eight addition problems. Both mathematical strategies were implemented over a 6-week period. The pre and posttests were collected without names. The scores ranged from zero to eight based on the number of correct responses. Following the administration of the instructional teaching strategy, the same Harcourt (2004) test was given as the posttest. An analysis of the pre and posttest data utilizing the SPSS statistical program and the research strategy, the independent-measure *t* test determined whether there was a statistically significant difference in outcomes between the treatment and the comparison group.

Before beginning data collection, the pretest was given to all of the participants. The pretest established each student's computational abilities prior to the TouchMath instruction or traditional math instructional strategies. If any students were absent the day of the pre or posttests, the day the students return, they were given the test later. Any questions that the teachers had were answered during that time. I helped both the experimental and control groups plan instruction to ensure consistency amongst the teachers.

The control group began by introducing the numbers one through 10 over a 2-week period using direct instruction and worksheets. On day 11, the control group participants reviewed the numbers one through 10 and the classroom teacher conducted informal assessments to ensure all of the students were able to recognize the numbers.

For students who were struggling, they received 20 extra minutes a day of small group instruction provided by a paraprofessional until mastery of number identification through 10. Next, the teachers introduced addition using manipulatives and worksheets for the students to use. A detailed description of the lesson plans are established in Appendix C.

The experimental group began by introducing the numbers one through 10 with the TouchPoints (Appendix D). On day 11, the experimental group participants reviewed the numbers and the classroom teacher did an informal assessment. Students who had not mastered the number recognition and TouchPoint locations received an extra 20 minutes of small group instruction with a paraprofessional. The participants received instruction using the TouchPoints to solve addition equations. Over the course of the study, the treatment group received TouchMath instruction incorporating the strategies from the extensive review of literature, including ways to implement Gardner's (1983) multiple intelligence, Dunn and Dunn's (1978) modalities, Vygotsky's (1986) ZPD, and Bruner (1966) and Piaget's (1975) stages of development into the math instruction. A detailed description of the TouchMath lesson plans is established in Appendix B.

Both the control and experimental groups had informal and formal assessments to ensure mastery of the skills. The teachers conducted informal assessments daily to check for understanding. On day 20, the teachers had the students complete a formal assessment to check the students' progress. Additional support was provided for students who were struggling throughout the 6-week study. On day 30, all of the participants completed the posttest (Appendix A).

The teachers taught the TouchMath program or traditional math instructional strategies over the 6-week period. All experimental sessions were conducted in a whole and small group format. Each whole group session was conducted 5 days per week for 30 minutes a day. Students who were struggling received small group instruction with a paraprofessional for an additional 20 minutes per day. During that time, I also assessed the students' progress through teacher-created assessments. At the end of the study, the students were given a Harcourt (2004) chapter posttest. Scores were collected and analyzed using descriptive statistics. Analysis determined if there was a statistical difference in the control and experimental groups.

Instrumentation and Measures

The Harcourt Math Assessment Guide's (2004) chapter test was used as the instrument for data collection. It was used for both the pre and posttests. The Harcourt Math Assessment Guide chapter test includes eight addition problems. Four of the problems contain two addends and four problems contain three addends. The problems are vertical where the problems go across and have an equal sign (2+2=4) and horizontal problems which are up and down with a line representing the equal sign. All eight problems have free response answers (Appendix A). The students were given 30 minutes to complete the pre and posttests.

Reliability and Validity

The reliability and validity of the instrument is vital to the accuracy of the results. Reliability is referred to as the consistency, accuracy, and stability of scores (Creswell, 2003). For this research, the Harcourt (2004) Assessment Guide was used to measure student achievement and measured the appropriate mathematical content taught throughout the study. The assessment is used throughout my school system. The assessment has not been modified and permission has been obtained to use the assessment (T. McCullough, personal communication, June 23, 2010). The assessment is known to have statistical reliability and has been measured by evaluating internal consistency, based on correlations between different items on the same test (Harcourt).

The Harcourt (2004) assessment guide had extensive field tests in four counties in Georgia to determine the appropriateness of materials and the validity of the tests materials. Harcourt found:

> The content validity of the tests was assured since they were developed in close alignment with the content of the program. In addition, the tests demonstrated constructs validity because they were very sensitive to gains in students' understanding, as demonstrated by the significant gain in scores. (p. 5)

Coefficient alphas measure internal consistency, with values ranging from 0 (none) to 1 (perfect consistency). The coefficient alpha values for the first grade through fifth grade assessments indicate acceptable levels of moderate to high internal consistency, with first grade assessments being .67 and .77 respectively (Harcourt).

The validity of a test refers to evidence that establishes how well a test measures or was designed to measure. The construct validity of the assessment includes eight addition problems. The participants of the study will learn number recognition one through 10 and instruction on solving addition equations. To maintain the internal validity of the test, I have discussed with the classroom teachers how to respond to questions students may have during the pre and posttests. The teachers did answer questions that students had during the pre and posttest. If a question arose, the teacher told the students to try their best. The teachers did not tell students an answer to a problem or help a child identify an unknown number. After the tests were given, the classroom teachers briefly looked over the tests. If a number was illegible, the teacher asked the student to verbally identify the number by saying “Can you tell me what number this is?” This ensured the teacher was not bias and maintain the validity of the test. To avoid threats that may involve procedural inadequacies, the teachers met every other day to discuss any procedural or treatment questions they had. These strategies helped to eliminate any internal threats to validity.

Coding and Scoring

The research involved the use of two different mathematical programs. Therefore, a coding system was created to distinguish the two mathematical programs. The classes that used the TouchMath program had the letters “TM” on their pre and posttests. The classes that used traditional teaching methods did not have any markings on their pre and posttest. The coding helped when analyzing the data to determine which class used the TouchMath program and which class used traditional teaching methods.

I scored the pre and posttests along with one classroom teacher whose students did not participating in the study. The classroom teacher signed a confidentiality agreement (Appendix E). Once all of the pre and posttests were given, the teachers met after school and scored the tests. Scoring was done by hand by these two people to enhance the reliability and validity of the research. There are eight addition problems on the pre and posttests. For each correct response, the participant received one point. A comparison between the math achievements of students who were taught using TouchMath verses those who were taught using traditional methods was determined based on the data.

Data Collection and Analysis

I determined whether there was a significant difference between the independent variable of instructional mathematical strategies, defined as the TouchMath program and traditional teaching methods, on the dependent variable, students' mathematical achievement, defined as a numerical score on the Harcourt (2004) assessment guide. The data collection for this quantitative quasi-experimental study was collected by means of a pre and posttests using an existing assessment created by Harcourt (Appendix A). The pre and posttests of all participants provided comparison data between the control and experimental groups to answer the research question.

Comparing the math achievement between the experimental group and the control group constituted an independent measures research design. The hypotheses were tested to determine whether there were significant differences in scores from the control group and the experimental group.

The participants of the study were 100 kindergarten students at ABC Elementary School in a northeast suburb of Atlanta, Georgia. The experimental groups, or Group A, consists of students who were taught using the TouchMath program and the control group, or Group B, consists of students who were taught through traditional means. Data was collected using the Harcourt (2004) chapter test. Scores were out of a possible eight correct responses. The data collected from the pre and posttests were then analyzed through statistical means. The statistical computer program SPSS for Windows version 14.0 was used to conduct the independent-measures t hypothesis test on both the pre and posttest data from the experimental and control groups (Salkind & Green, 2003). An independent-measures *t* test was utilized for the data collected from two separate samples, the experimental group and the control group, to determine if students who used the TouchMath program demonstrate a higher level of computational abilities to those who were taught through traditional means. Using a *t* test, I was able to compare two different sets of data, taken from the two different mathematical instructional strategies. The *t* test assessed whether the means of the two groups were statistically different from each other (Gravetter & Wallnau, 2005).

Descriptive statistics were also be used to summarize the data in a clear and understandable manner (Creswell, 2003). The descriptive methods included the mean, standard deviation, and standard error of the mean. Since standard deviation was used to determine the distance of the mean, Cohen's *d* was also used to help measure the effected size of the treatment effect in terms of the standard deviation. The standard error was analyzed to provide me with an indication of how accurately their represents the population.

Ethical Considerations

To ensure that the rights of all participants were protected, permission was sought and granted approval from the ABC Elementary School's principal to proceed with the study by completing a Local School Research Request Form which allows me to conduct the study within the school setting. The request form was approved by the principal at ABC Elementary and filed at the County Research Office (Appendix F). I also received a Data Usage Agreement (Appendix G) from the principal of ABC Elementary School. Since this study used a curriculum that is already in place at ABC Elementary School, parental consent was not required. To ensure the participants of the study remained anonymous, I created a Confidentiality Agreement for the classroom teacher that assisted in grading the pre and posttest (Appendix E). These measures were in place to ensure students' rights are maintained appropriately. Permission to conduct the research was also requested and approved from Walden's IRB board.

I am a kindergarten teacher at the elementary school where the study was conducted. I established and maintained professional data collecting procedures to ensure the protection of the participants. I met with the six teachers that administered the treatment and the pre and posttests to discuss the anonymity of the participants. To further ensure that participants' rights were protected, the name of the school and the names of all participants are not documented within this study. Any identifying information pertaining to test scores and achievement gains were only known to academic teachers involved with the student for purposes of assignment within the content of math instruction. All data collected remained under lock and key under my supervision. This study was approved through the Institutional Review Board on February 16, 2011 (02-16-11-02809310).

Summary

This quantitative study compared the achievement of kindergarten students who were taught using the TouchMath program to those who were taught through traditional teaching methods using a quasi-experimental nonequivalent control-group design. Local reports indicate students are struggling with mathematical content (U.S. Department of Education, 2007). At the site where the research was conducted, the students must pass a state mandated test for promotion to fourth grade. Math achievement is a major concern for administrators, parents, students, and teachers. Research and case studies have shown the TouchMath program to be an effective tool when learning mathematics. A study of the TouchMath program to increase mathematical understanding and achievement is a worthy investigation that may benefit students at ABC Elementary School.

Statistical analyses were performed using SPSS for Windows version 14.0 (Green & Salkind, 2003). A *t* test for independent samples was used to test for statistical significance of achievement gains between the experimental group and control group. The research design involved separate and independent samples in order to make a comparison between the two groups of individuals. Achievement scores were analyzed by investigating the mean and standard deviation of achievement scores for each set of data for the participants in order to determine the effectiveness of the TouchMath program as an instructional strategy among kindergarten students.

The remaining sections of this doctoral study will present the findings of the research study (section 4), and conclusions and future recommendations for other professionals (section 5).

Section 4: Analysis of Data

Introduction

This section includes the results of this quantitative study using the quasi-experimental nonequivalent pre and posttest control group design. A decrease in math achievement at ABC Elementary School and in the state of Georgia sparked an interest for this study. Concerned educators are searching for a mathematical program that is developmentally appropriate for kindergarten students and increases math achievement. This section provides the results of this quantitative study.

The purpose of this study was to measure the effectiveness of two instructional methods on the computation abilities of a group of kindergarten students. I focused on the TouchMath program and traditional mathematical teaching practices. An investigation into peer reviewed journals and books about constructivism, learning styles, developmentally appropriate teaching practices, and math instruction were the foundation of this research. The participants of this study were 100 kindergarten students at ABC Elementary School. The students were randomly placed in six different kindergarten classes. The following research question was investigated by this study: Is there a difference in computational abilities between kindergarten students taught by the TouchMath program and those taught through traditional means? During the 6-week study, three classroom teachers implemented traditional mathematical teaching strategies daily for 30 minutes to 50 students in the control group. Over the same period of time, three classroom teachers implemented the TouchMath program to 50 students in the experimental group.

The Harcourt Chapter Test (2004) was administered to the experimental and control groups by the respective teachers of each of the six kindergarten classes at the beginning of the study. This assessment was used for pretest data. Following specific lesson plans, the students were introduced to the TouchMath program or traditional teaching methods over a 6-week period. Following the same procedure as the pretest, the Harcourt Chapter Test (2004) was given to the same 100 participants, in the experimental and control groups, at the end of the 6-week study. In order to answer the research question, I compared the pre and posttest scores of the experimental and control groups to determine if gains were made in their computation abilities. Utilizing the pre and posttest method allowed me to identify a change caused by the independent variable by comparing the results. This section describes the research tools utilized, the data analysis, and a summary of the findings.

Research Tools

The data collection tool used for this study was the Harcourt Math Assessment Guide’s (2004) chapter test. This instrument was administered to determine students’ mathematical abilities before and after the instructional interventions. The 100 participants were given the chapter test to monitor student progress against the county curriculum standards, address deficiencies, and check for mastery. The Harcourt Math Assessment Guide chapter test includes eight addition problems. Four of the problems contain two addends and four problems contain three addends. All eight problems have free response answers. For each correct response, the participant received one point, with a possible of eight total points.

The Harcourt (2004) Assessment Guide was used to measure student achievement. The assessment is known to have statistical reliable and has been measured by evaluating internal consistency, based on correlations between different items on the same test (Harcourt). Coefficient alphas measure internal consistency, with values ranging from 0 (none) to 1 (perfect consistency). The coefficient alpha values for the first grade through fifth grade assessments indicate acceptable levels of moderate to high internal consistency, with first grade assessments being .67 and .77 respectively (Harcourt).

The pretest was given to all 100 students prior to beginning the study. I scored the pretest by hand along with a classroom teacher whose students did not participating in the study. Having two people score the pre and posttests enhanced the reliability and validity of the research.

For the duration of the 6-week study, the classroom teachers followed the lesson plans that I created. Three classroom teachers provided math instruction to 50 students in the control group, utilized traditional mathematical lesson plans (Appendix C). Over the same period of time three classroom teachers implemented the TouchMath program for 30 minutes a day, to the 50 students in the experimental group (Appendix B).

After completing the 6-week study, the Harcourt Chapter Test (2004) was administered to all 100 participants in the study by their perspective teachers. I scored the chapter test, along with one classroom teacher whose students are not participating in the study. The Statistical Program for the Social Sciences (SPSS) was used to conduct the independent-measures *t* test on both pretest and posttest data from the experimental and control groups. The independent-measures *t* hypothesis test was used to evaluate the mean difference of each sample to determine if there was a significant difference between the two sets of scores. It was my responsibility to analyze the results derived from the statistical program to determine if there was a significant difference in instructional strategies on math achievement.

Role of the Researcher

My many roles as researcher designer, data collector, analyst, and interpreter were important through this process. As researcher designer, my role was to ensure that this study was an accurate measure of the effectiveness of math instruction that the data would be replicable, and that results reflected the effects of the TouchMath program. During this 6-week study, I supervised all aspects of the research. I copied and distributed all materials to the classroom teachers and explained their role in the study. I wrote specific lesson plans for the teachers to follow. My role was a facilitator, motivator, and supporter to the six teachers involved in the study. This support included in-service training, modeling lessons, and informal coaching when needed.

It was important for me, as the researcher, to remove any bias that I possessed. I have used the TouchMath program for several years and have seen a significant difference in my students' mathematical achievement, so I was aware some bias may exist. To ensure my biases were not presented to the classroom teachers, I expanded my understanding, clarified questions, and checked for accuracy of interpretation (Merriam, 2002).

Merriam (2002) found the researcher is the primary instrument for data collection.

As data collector, my role was to make sure the data collected was collected under normal conditions and accurately reflected student learning. In analyzing the data, it was important to extract the applicable and pertinent data. My role as interpreter was a significant one. Synthesizing the information, interpreting it, and considering future applications and implications to the students in my classroom, as well as the larger context, are crucial in making this study an important one. As the researcher, it was my goal to gain a holistic overview of the students' achievement.

Data Analysis

I explored the TouchMath program in depth and its impact on kindergarteners' computation abilities over a 6-week time period. Control and experimental groups were used to determine if there was a significant difference in computational abilities between kindergarten students taught using the TouchMath program and those taught through traditional means. To determine whether there was significant difference in test scores of the variables (instructional method), SPSS, specifically a *t* test, was used to analyze the data from the pre and posttest to compare the difference in achievement for both groups of students. The *t* test for two independent samples was used to determine the statistical difference of the mean scores concerning mathematical achievement for 100 kindergarten students receiving traditional mathematical teaching practices and the TouchMath program.

I investigated the difference between the independent variables of instructional strategies, including the TouchMath program and traditional teaching practices, on the dependent variable of computation achievement. There were 50 participants in the control and 50 students in the experimental groups who participated in the 6-week study.

Research Question

Is there a difference in computational abilities between kindergarten students taught by the TouchMath program and those taught through traditional means?

H_0: There is no significant difference in math scores for kindergarten students who are exposed to the TouchMath program compared to those who are taught through traditional means.

H_1: There is a significant difference in math scores for kindergarten students who are exposed to the TouchMath program compared to those who are taught through traditional means.

Descriptive statistics aim to quantitatively summarizing distributions of scores by developing a graphical representation and computing descriptive statistical indices. Even when data analysis draws its main conclusion, using inductive statistical analysis, descriptive statistics are generally presented along with more formal analyses to give the audience an overall sense of the data being analyzed (Gravetter & Wallanu, 2008). The goal of inductive statistics is making conclusions about a population based on the information extracted from a random sample. An alpha of .05 was used to justify whether there was statistical significance to accept or reject the hypothesis.

The statistical program SPSS, was used to analyze the data in order to measure the variance in scores between the control and experimental groups. Using a *t* test for two independent samples determines if there is a significant difference in the mean scores concerning mathematical achievement for kindergarten students receiving traditional mathematical instruction and the TouchMath program. The *t* test assesses whether the mean of two groups are statistically different from each other. This analysis is appropriate whenever you want to compare the means of two groups using a pre and posttest design. An alpha of .05 was used on all tests.

Interpretation

This quantitative study determined whether there was a significant difference between the independent variable of mathematical instructional strategies, defined as the TouchMath program or traditional teaching strategies, on the dependent variable, students' mathematical achievement, defined as a numerical score on the Harcourt chapter test (2004). The results of this study show there is a significant difference between the independent variable on the dependent variable. Therefore the alternative hypothesis was accepted and the null hypothesis was rejected. Comparing the pre and posttest data of 50 students in the experimental group and 50 students in the control group constitutes an independent measures research design. The hypothesis was tested to determine whether there is a significant difference in the scores from the control group and the experimental group. The pre and posttest scores for the control group and experimental group are shown in Table 1 and Table 2.

Table 1

Control Group: Pre and Posttest Scores

Number Correct	Pretest	Posttest
0	29	3
1	7	2
2	4	1
3	1	3
4	2	5
5	1	11
6	0	11
7	2	8
8	4	6
Total	50	50

The difference between the pre and posttest scores for the control group was calculated by comparing the means for the pre and posttests. The mean score for the pretest was M = 1.54 and the posttest mean was M = 5.16 indicating there was an average gain of 3.62.

Table 2

Experimental Group: Pre and Posttest Scores

Number Correct	Pretest	Posttest
0	33	0
1	5	1
2	2	3
3	2	3
4	1	2
5	2	2
6	1	6
7	2	11
8	2	22
Total	50	50

The difference between the pre and posttest scores for the experimental group was calculated by comparing the means for the pre and posttests. The mean score for the pretest was M = 1.30 and the posttest mean was M = 6.46 indicating there was an average gain of 5.16.

Data analysis revealed there was a difference in mathematical achievement of students who utilized the TouchMath program. Using the SPSS program, the statistical differences between both groups' means scores are shown in Table 3.

Table 3

Mean and Standard Deviations for the Control Group and the Experimental Group

Group	Mean	SD
Pretest Scores:		
Control Group	1.54	2.573
Experimental Group	1.30	2.367
Posttest Scores:		
Control Group	5.16	2.160
Experimental Group	6.46	2.012

The mean score for the control group's pretest, with 50 participants was 1.54 and a standard deviation of SD = 2.573. The mean score for the posttest was M = 5.16 with a standard deviation of SD = 2.160.

The mean score for the experimental group's pretest, with 50 participants, was M = 1.30 and a standard deviation of SD = 2.367. The mean score for the posttest was M = 6.46 with a standard deviation of SD = 2.012.

The data indicates the experimental group resulted in significant higher mathematical achievement. The posttest mean scores were 5.16 for the control group and 6.46 for the experimental group.

In order to compare the data from the control group and experimental group an independent *t* test was conducted. If there is a significant difference between the groups' mean scores and *p* values, a determination is made to accept or reject the null hypothesis. Table 4 illustrated the data derived from the independent *t* test.

Table 4

Independent Samples Test Analysis for the Post-test Score

Source	*Df*sig (2-tailed)	MD	F	T	Sig	
Equal variances assumed	98	.002	-1.300	.033	-3.113	.856
Equal variances not assumed	97.509	.002	-1.300		-3.113	

*p<.05

The independent *t* test results in *t* (98) = -.3.113, *p* = .002, two-tailed. The *t* value of the difference between the pre and posttest scores is -3.113, with degrees of freedom equal to 98. The two-tailed probability of .002 is less than .05 and therefore, the test is considered significant. As a result, the data indicates that the null hypothesis should be rejected and the alternative hypothesis is accepted. I concluded the experimental group increased their computation abilities on the posttest data when compared to the control group. Students in the experimental group, taught using the TouchMath program (M = 6.46, SD = 2.012) achieved higher scores that those students in the control group, who were taught through traditional means (M = 5.16, SD = 2.160). The 95% confidence interval for the difference in means ranged from -2.129 to -.471. The Boxplot Graph shows the growth distributions for the two groups (Figure 1).

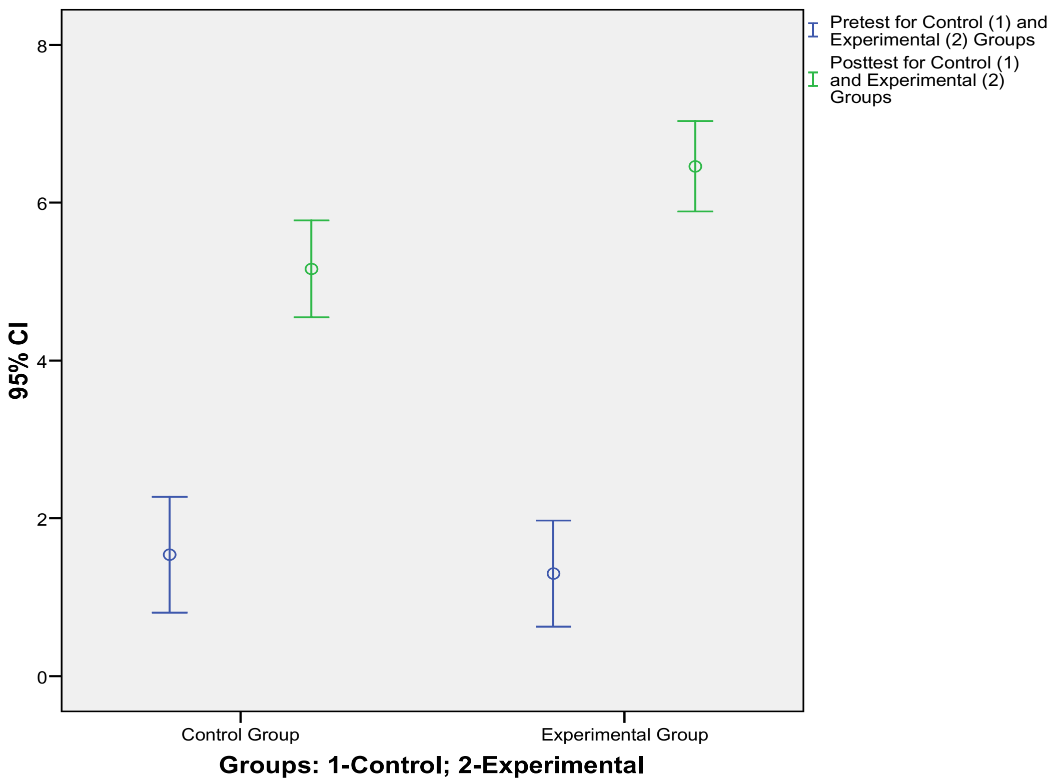

Figure 1. Boxplots of pre- post-test growth in the control and experimental groups.

The growth between the control group and experimental group is show in the Boxplot graph. According to Green & Salkind (2003), a Boxplot graph provides a representation of the variables. The median for each variable is shown by a circle on the line figure. Figure 1 illustrates the distribution for both variables and both groups. The visual representation is indicative of a greater increase in mathematical achievement from the pretest to the posttest scores for the control and experimental groups. This visual illustrates that there is a difference in computation achievement when comparing the TouchMath program to traditional teaching methods.

Possible Alternative Interpretation of the Findings

There are several possible alternative interpretations of the findings that may have attributed to the results of this study including the delivery methods of the classroom teacher, prior knowledge, and the diversity of the students. I created lesson plans that were carefully laid out for the teachers to follow, however teachers instructional delivery may vary, which may have affected their math achievement. Another alternative interpretation of the findings may be attributed to the amount of math instruction the students were exposed to prior to beginning the research. Wallace et al. (2007) found students are exposed to a variety of many informal mathematical learning experiences prior to entering a formal school setting. Data were collected during the last marking period of the kindergarten year. Many students were involved in various math instruction, homework, and class work depending on the individual teacher. The amount of math the students were engaged in would affect their math achievement.

The final alternative interpretation of the findings may be attributed to the diversity of each kindergarten class who participated in the research. The classes were formed from random selection. Therefore, the various language levels of both the students and their families are not similar from class to class. The research site had a diverse population with a percentage of bilingual students in each class. The bilingual students are identified as either Non-English Proficient (NEP) or Limited English

Proficient (LEP). The students participating in the research may be at various levels with various skills, which influenced their mathematical abilities and outcomes for this study. These are some of the factors that may have played a role in the outcome of the results of this study.

Conclusion

The purpose of this quasi-experimental quantitative study was to evaluate the relationship between math instructional methods and the computation abilities of a group of kindergarten students at ABC Elementary School in a northeastern suburb of Atlanta, Georgia. The study examined the theories of constructivism by comparing the effectiveness of the TouchMath program on the Harcourt Math Assessment Guide (2004). Specifically, I attempted to determine if there is a difference in the computational abilities of kindergarten students who are exposed to the TouchMath program compared to those who are taught through traditional means.

To determine whether there is significant difference in test scores of the variables (instructional method), SPSS, specifically a *t* test was used to analyze the data from the pre and posttest to compare the difference in achievement for both groups of students. Using a *t* test for two independent samples determines if there is a significant difference in the mean scores concerning mathematical achievement for kindergarten students receiving traditional mathematical instruction and the TouchMath program. An independent-samples *t* test was conducted to evaluate the hypothesis that students taught using the TouchMath program achieved higher score on the Harcourt Chapter test. The test was significant $t\ (98) = -.3.113$, $p = .002$. As a result, I accepted the alternative hypothesis which indicates there is a significant difference in math achievement between students who were taught using the TouchMath program and those who were taught through traditional means. I must reject the null hypothesis, which states there is no significant difference in math scores for kindergarten students who are exposed to the TouchMath program compared to those who are taught through traditional means.

The findings of this study support the use of the TouchMath program to increase students' computation achievement in a kindergarten setting. The final section of this study will review the outcomes of this study, how it relates to the conceptual framework, practical applications, implementations for social change, and recommendations for future studies.

Section 5: Summary, Conclusions, and Recommendations

Introduction

There is a problem in the academic achievement at ABC Elementary School, in Northeast Georgia. The problem is a 55% increase in the number of students who did not meet the minimal requirements between the 2004-2005 and 2005-2006 school years on the first grade mathematics section of the CRCT (U.S. Department of Education, 2007). Studies also showed 68% percent of fourth-grade students in Georgia are meeting the minimum standards on state mandated tests (U.S. Department of Education, 2007). These deficits in mathematical achievement, coupled with the stricter educational requirements and standards established by NCLB are a concern to educators in Georgia and at ABC Elementary School (U.S. Department of Education). Nationally, early childhood educators are trying to find a balance between developmentally appropriate practices and the required achievement benchmarks identified by NCLB (NAEYC, 2009). The NAEYC found educators who are knowledgeable about a child's developmental level are able to create an environment and activities to promote achievement.

The purpose of this study was to determine if there was a difference in the computational abilities of kindergarten students who are exposed to the TouchMath program to those who are taught through traditional means. The TouchMath program is based on the constructivist learning theory and includes many educational researchers' theories such as Bruner (1966), Gardner (1983), and Piaget (1966). The research design was a quasi-experimental, quantitative nonequivalent control-group design. The participants of this study were 100 kindergarten students at ABC Elementary School. The students were randomly placed in six different kindergarten classes. The experimental group was taught using the TouchMath program and the control group was taught using traditional teaching methods. Both groups were selected without random assignment and took the Harcourt (2004) chapter test as the pre and posttest. An independent samples *t* test was the statistical test used to compare two different sets of data, taken from two different mathematical instructional strategies. The results of this study showed there was a significance difference in students who were taught using the TouchMath program to those who were taught through traditional teaching methods.

Interpretation of Findings

The following research question was investigated by this study: Is there a difference in computational abilities between kindergarten students taught by the TouchMath program and those taught through traditional means? Both mathematical strategies were implemented over a 6-week period. To measure the effectiveness of the TouchMath program on kindergartener's mathematical achievement, pre and posttest data was collected and analyzed using the Harcourt Assessment Guide (2004). The SPSS statistical program was utilized to test the hypothesis to determine if there was a significant difference between instructional strategies and mathematical achievement. The pretest mean score for the control group was M = 1.54 and the posttest mean was M = 5.16 indicating there was an average gain of 3.62. While the pretest mean score for the experimental group was M = 1.30 and the posttest mean was M = 6.46 indicating there was an average gain of 5.16. The independent *t* test resulted in *t* (98) = -.3.113, *p* = .002, two-tailed. The *t* value of the difference between the pre and posttest scores is

-3.113, with degrees of freedom equal to 98. The two-tailed probability of .002 is less than .05 and therefore, the test is considered significant. As a result, the data indicates that the null hypothesis should be rejected and the alternative hypothesis is accepted. The research concludes the experimental group increased their computation abilities on the posttest data when compared to the control group.

With NCLB (2002), educators are under pressure to ensure the academic success of their students. Yet, the rigor of kindergarten programs may be developmentally inappropriate (Jewell, 2009). The TouchMath program is found to have developmentally appropriate teaching strategies and has shown to improve students' computation abilities (Jarrett & Vinson, 2005; Newman, 1994; Scott, 1993). The theoretical basis for this study is the constructivist learning theory. It was developed by many educational researchers including Bruner (1966), Gardner (1983), Piaget (1966), and Vygotsky (1986). Bruner and Piaget have theories that are similar to the philosophy of TouchMath in that sequential learning strategies are applied and as a result students learn mathematical skills more effectively and improve at a quicker rate. Vygotsky's theoretical framework allows children to learn from one another, while Gardner's multiple intelligences allow children to learn in their preferred interest. The TouchMath program has incorporating multiple learning strategies into the instruction, which is shown to have a significant impact on student achievement (Jarrett & Vinson; Newman; Scott). These strategies are consistent with the constructivist learning theory.

The results of this study showed that the TouchMath program had a positive impact of student achievement. These results are consistent with the findings of Jarrett and Vinson (2005), Newman (1994), and Scott (1993). This study should contribute to existing research with its large population and longevity of the study. By exploring the use of the TouchMath program and how it incorporates the theories of constructivism, this study addresses the decrease in math scores on the state mandated assessments and increase academic achievement in mathematics. Because there is a need to increase math achievement in Georgia's school, this study can support educational leaders in bringing about change to implementing a developmentally appropriate mathematical strategy that have shown to increase student achievement.

Designing a curriculum for improving mathematics education can be part of systemic education reform, including national standards that contribute to state and local districts. Legislators, superintendents, school board members, administrators, and educators are responsible for providing effective mathematics instruction and materials to students. These stakeholders have the power to provide improvements in mathematics achievement. This research has the potential to be a changing force for this school's teaching practices and increase students test scores on the CRCT.

Implications for Social Change

Increasing student achievement in mathematics is an issue that is front and center for educators on the national, state, and local levels. According to the NAEY (2009), "whether NCLB and similar 'accountability' mandates can deliver that result is hotly debated, and many critics argue that the mandates have unintended negative consequences for children, teachers, and schools" (p. 3). School districts and educators are facing challenges brought about by NCLB and the required state mandated tests.

States and districts have created rigorous curriculums and high stake tests that students are required to pass (Jewell, 2009). This challenges educators to find educational programs to improve their students' academic achievement and increase test scores. The TouchMath program has shown to increase student achievement through developmentally appropriate practices (Jarrett & Vinson, 2005; Newman, 1994; Scott, 1993). This research should contribute to the existing body of knowledge necessary to address the decrease in children's conceptual knowledge in mathematics and examine developmentally appropriate teaching techniques using the TouchMath program.

I utilized the TouchMath program as an instructional strategy to increase kindergarteners' mathematical achievement and found students who used the program obtained greater gains on the Harcourt (2004) chapter test. The outcome of this study revealed that implementing the TouchMath program had a positive influence on math achievement. It is relevant to social change because it describes instructional strategies that increase computational abilities and is known to have developmentally appropriate practices for kindergarten students (Jarrett & Vinson, 2005; Newman, 1994; Scott, 1993). The study may have a positive influence on social change by helping students acquire a mathematical foundation necessary to acquire more complex concepts. In order for social change to successfully occur, it is important for all stakeholders, teachers, parents, students, support staff, and other community leaders, to aid in student achievement and improvement. Stakeholders should be willing to make a change and provide the support that is needed for students to succeed.

This study may bring about social change in the local community by preparing students with a solid mathematical foundation who are more prepared for complex skills and concepts. The school may be impacted because students will be more prepared for state mandated tests, while increasing the schools' Adequate Yearly Progress. In addition, the national and global community may be impacted because students will be provided with instructional practices that will increase their mathematical foundation, enabling them to build upon that knowledge for more complex skills. Effective math skills are necessary to be successful life-long learners in a global environment. In order to complete in a global marketplace, it is imperative that students have the mathematical skills necessary to do so.

Recommendations of Actions

This study has shown to increase students' computation abilities using the TouchMath program. The purpose of this study was not only to determine whether the TouchMath program increased student achievement, but to share the findings with educator and other stakeholders who are concerned and committed to improve student achievement. Student achievement is based on how students are taught, how they learn, whether they are able to understand, master, retain, and apply their knowledge. TouchMath is one program that can be implemented to aid in student achievement (Bullock, 2005).

Based upon the results of this study, I would like to share this study with administrators and teachers considering implementing the TouchMath program into their classroom. The lesson plans can be used to execute the program effectively into their classrooms and reinforce the theoretical foundation that supports its developmentally appropriate teaching strategies. Administrators can examine the results of this study and share it with the faculty as a form of staff development. Attending staff developments on the TouchMath program is one avenue to enhance teachers' knowledge on the program and how it integrates the constructivist learning theory. Implementing the TouchMath program into their school may increase tests scores not only in the classroom, as this study revealed, but on state mandated assessments. The issue of quality mathematical programs is important for educators. The current trend is to come out with new mathematical strategies that will help increase mathematical knowledge, the TouchMath program is one of these programs.

Sharing the results with parents is also a recommendation. Parents expect the best mathematical programs available for their children to give them every advantage and opportunity for success. Sharing the results of this study with parents and explaining how the program works, will enable them to assist educators and reinforce the skills taught at school.

As required by NCLB (2002), educators are to close the achievement gap by the year 2014. Administrators, educators, parents, and stakeholders are aware it is critical that we address student achievement. This study addressed the achievement gap concern as it has shown an increase in student achievement using the TouchMath program in a diverse suburban school. It is crucial that all students have a strong mathematical foundation to succeed in the classroom and on the required state mandated tests. The TouchMath program may help achieve this goal.

Recommendations for Further Studies

The TouchMath program has shown to increase students' math achievement (Jarrett & Vinson, 2005; Newman, 1994; Scott, 1993). This study had similar results. Much more research is needed to determine if the TouchMath program is an effective mathematical program. The following recommendations could enhance the available research.

This study was limited to one kindergarten classroom in a diverse suburban school, in the state of Georgia. There is a need to encompass a variety of grade levels, schools, and populations. The results of such further studies would examine different outcomes and ultimately determine the effectiveness of the TouchMath program.

Another recommendation is to change the time of the year the study is conducted. This study was conducted in the last quarter of the school year. Most of the students were able to accurately identify the numbers one through 20, prior to the start of the research. Conducting the study at the beginning or midyear may have different results. If the study is conducted earlier in the school year, I would recommend extending the period for collecting data. This will enable the researcher to spend more time on number identification and TouchPoint locations to help ensure success with computation skills.

Using a variety of assessments to measure the effectiveness of the TouchMath program is my final recommendation. I would recommend comparing students' scores who were taught using the TouchMath program to those who used traditional methods on the CRCT. With pressure to do well on standardize tests and compete in a global market, it is imperative that best practices are investigated to obtain optimum results.

A child's success in school is dependent on a variety of things. This research has shown that the TouchMath pogrom will provide students with the necessary skills, which may improve their chance for success. It is imperative that teachers, administrators, and parents understand the complexity and importance a child's mathematical foundation.

Conclusion

The purpose of this quasi-experimental quantitative study was to evaluate the relationship between instructional strategies and the computation abilities of a group of kindergarten students at ABC Elementary School in a Northeastern suburb of Georgia. The research design was a quasi-experimental, quantitative nonequivalent control-group design. The experimental group was taught using the TouchMath program and the control group was taught using traditional teaching methods. Both groups were selected without random assignment and took a pre and posttest. To test the null hypothesis, an independent-samples *t* test was the statistical test used to compare two different sets of data, taken from two different mathematical instructional strategies.

The research was conducted over a 6-week period with 100 participants from six kindergarten classrooms. The classroom teachers followed specific lesson plans during the 6-week period. Data was collected using the Harcourt Assessment Guide (2004) chapter test as the pre and posttests. Based on the independent samples *t* test conducted, there was a significant difference in math achievement for students who were taught using the TouchMath program. As a result, I concluded that implementing the TouchMath program had a positive impact on student achievement.

In classrooms of diverse learners, meeting the needs of all students is vital. This study provides educators with objective data which can be used to evaluate two instructional strategies. The kindergarten curriculum in schools has become developmentally inappropriate, yet all students are expected to achieve equally and meet the high standards despite their varied abilities (Jewell, 2009). The only way to meet the needs of all students is to explore and study mathematical strategies that increase student achievement and are developmentally appropriate. The TouchMath program is shown to have developmentally appropriate practices as it takes the constructivist approach to teaching by incorporating Piaget (1966) and Bruner's (1966) developmental theories, while increasing math achievement. This research contributed to the body of knowledge needed to address the decrease conceptual knowledge in mathematics and examine developmentally appropriate teaching techniques using the TouchMath program.

This study should contribute to the existing research because it was conducted over an extended period of time and had a large population. The outcome of this research may guide educators, administrators, and curriculum personnel to take a closer look at the math curriculum in their own schools and districts. Addressing concerns of math instruction and achievement is imperative during the current era of high-stakes testing. The ability to perform complex mathematical operations is vital in today's society.

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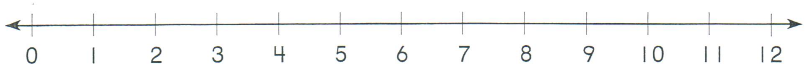
Appendix A

Pre/Posttest

Name ____________________ CHAPTER 12 TEST • PAGE 1

For 1–8, add.



1. $\begin{array}{r} 8 \\ +3 \\ \hline \end{array}$

2. $7 + 1 =$ ___

3. $\begin{array}{r} 4 \\ +5 \\ \hline \end{array}$

4. $4 + 2 =$ ___

Go On

Name ______________________

5. 4 + 3 + 1 = ___

6.
$$\begin{array}{r} 5 \\ 3 \\ +2 \\ \hline \end{array}$$

7.
$$\begin{array}{r} 1 \\ 1 \\ +5 \\ \hline \end{array}$$

8.
$$\begin{array}{r} 2 \\ 3 \\ +5 \\ \hline \end{array}$$

Stop

Appendix B

TouchMath Lesson Plans

Day 1: Using the TouchMath program's Counting Kit materials, introduce the number 1 to the students. Show the students the number with the picture of the one seal, hat, ball, and stripe on it that represents the one TouchPoint. Next show the students how to make a number 1. Give the students a piece of paper and have them practice writing the number 1 five times. Then have them put an object for a junk box on the number to represent the TouchPoint. Finally, show the students how to represent the TouchPoint using a dot.

Day 2: For morning work, have the students practice writing the number 1 and putting the 1 TouchPoint on the number using crayons, colored pencils, markers, or pencils. During math instruction, use the Counting Kit materials to introduce the number 2 to the students. Show the students the number with the pictures that represents the TouchPoints. Next show the students how to make a number 2. Give the worksheet from the Counting Kit to trace and write the number 2. Then have them put objects on the number to represent the TouchPoints. Finally, show the students how to represent the TouchPoint using a dot and practice touching and counting the TouchPoints to represent that number.

Day 3: For morning work, have the students practice writing the number 2 and putting the 2 TouchPoints on the number using crayons, colored pencils, markers, or pencils. During math instruction, use the Counting Kit materials to introduce the number 3 to the students. Show the students the number with the pictures that represents the TouchPoints. Next show the students how to make a number 3. Give the worksheet from the Counting Kit to trace and write the number 3. Then have them put objects on the number to represent the TouchPoints. Finally, show the students how to represent the TouchPoint using a do practice touching and counting the TouchPoints to represent that number.

Day 4: For morning work, have the students practice writing the number 3 and putting the 3 TouchPoints on the number using crayons, colored pencils, markers, or pencils. During math instruction, use the Counting Kit materials to introduce the number 4 to the students. Show the students the number with the pictures that represents the TouchPoints. Next show the students how to make a number 4. Give the worksheet from the Counting Kit to trace and write the number 4. Then have them put objects on the number to represent the TouchPoints. Finally, show the students how to represent the TouchPoint using a dot practice touching and counting the TouchPoints to represent that number.

Day 5: For morning work, have the students practice writing the number 4 and putting the 4 TouchPoints on the number using crayons, colored pencils, markers, or pencils. During math instruction, use the Counting Kit materials to introduce the number 5 to the students. Show the students the number with the pictures that represents the TouchPoints. Next show the students how to make a number 5. Give the worksheet from the Counting

Kit to trace and write the number 5. Then have them put objects on the number to represent the TouchPoints. Finally, show the students how to represent the TouchPoint using a dot practice touching and counting the TouchPoints to represent that number.
Day 6: For morning work, have the students practice writing the number 5 and putting the 5 TouchPoints on the number using crayons, colored pencils, markers, or pencils. During math instruction, use the Counting Kit materials to introduce the number 6 to the students. Show the students the number with the pictures that represents the TouchPoints. Next show the students how to make a number 6. Give the worksheet from the Counting Kit to trace and write the number 6. Then have them put objects on the number to represent the TouchPoints. Finally, show the students how to represent the TouchPoint using a dot practice touching and counting the TouchPoints to represent that number.

Day 7: For morning work, have the students practice writing the number 6 and putting the 6 TouchPoints on the number using crayons, colored pencils, markers, or pencils. During math instruction, use the Counting Kit materials to introduce the number 7 to the students. Show the students the number with the pictures that represents the TouchPoints. Next show the students how to make a number 7. Give the worksheet from the Counting Kit to trace and write the number 7. Then have them put objects on the number to represent the TouchPoints. Finally, show the students how to represent the TouchPoint using a dot practice touching and counting the TouchPoints to represent that number.

Day 8: For morning work, have the students practice writing the number 7 and putting the 7 TouchPoints on the number using crayons, colored pencils, markers, or pencils. During math instruction, use the Counting Kit materials to introduce the number 8 to the students. Show the students the number with the pictures that represents the TouchPoints. Next show the students how to make a number 8. Give the worksheet from the Counting Kit to trace and write the number 8. Then have them put objects on the number to represent the TouchPoints. Finally, show the students how to represent the TouchPoint using a dot practice touching and counting the TouchPoints to represent that number.

Day 9: For morning work, have the students practice writing the number 8 and putting the 8 TouchPoints on the number using crayons, colored pencils, markers, or pencils. During math instruction, use the Counting Kit materials to introduce the number 9 to the students. Show the students the number with the pictures that represents the TouchPoints. Next show the students how to make a number 9. Give the worksheet from the Counting Kit to trace and write the number 9. Then have them put objects on the number to represent the TouchPoints. Finally, show the students how to represent the TouchPoint using a dot practice touching and counting the TouchPoints to represent that number.

Day 10: For morning work, have the students practice writing the number 9 and putting the 9 TouchPoints on the number using crayons, colored pencils, markers, or pencils. During math instruction, use the Counting Kit materials to introduce the number 10 and how to make a number 10. Give the worksheet from the Counting Kit to trace and write the number 10.

Day 11: For morning work, have the students practice writing the number 10. During math instruction, review the numbers 1-10 with the students. Using the foam numerals from the Counting Kit, have the students work in groups of 4 to put the numbers in order from one to 10. Then have the students put the foam circles on the numerals to represent the TouchPoints. Finally, review how to write each number and have the students write each number 5 times each on a blank piece of paper and put a dot on the numbers to represent the TouchPoints. Using flashcards, conduct and informal assessment of the student's knowledge of the numbers one through 10.

Day 12: Discuss the concept of addition. Using materials from the TouchMath Addition Kit, have the students use color and count the objects in the left column and write the total number. Then have the students put manipulatives on the TouchPoints on the right column, count the manipulatives, and write the total number. Have the students compare the answers and discuss.

Day 13: Review the concept of addition. Using materials from the TouchMath Addition Kit, have the students use color and count the objects in the left column and write the total number. Then have the students put the TouchPoints on the numbers in the right column, count the TouchPoints, and write the total number. Have the students compare the answers and discuss.

Day 14: Repeat the directions from day 13 directions using sums that equal 0-5.

Day 15: Repeat the directions from day 13 directions using sums that equal 0-7.

Day 16: Repeat the directions from day 13 directions using sums that equal 0-10.

Day 17: Using the TouchMath Addition Kit materials, have the students complete and solve the worksheet with 3 vertical addition problems using manipulatives, pictures, and TouchPoints. Have the students compare and discuss the solutions.

Day 18: Repeat the directions from day 17 using sums that equal 0-5.

Day 19: Repeat the directions from day 17 using sums that equal 0-5.

Day 20: Assess the students' knowledge for the sums of 0-5.

Day 21: Using the TouchMath Addition Kit materials, have the students complete and solve horizontal addition problems that equal 0-6.

Day 22: Using the TouchMath Addition Kit materials, have the students use manpulatives, pictures, or TouchPoints to complete and solve horizontal addition problems that equal 0-8.

Day 23: Using the TouchMath Addition Kit materials, have the students use manpulatives, pictures, or TouchPoints to complete and solve horizontal addition problems that equal 0-10.

Day 24: Using the TouchMath Addition Kit materials, have the students use manpulatives, pictures, or TouchPoints to complete and solve horizontal addition problems that equal 0-10.

Day 25: Using the TouchMath Addition Kit materials, have the students use manpulatives, pictures, or TouchPoints to complete and solve horizontal and vertical addition problems that have three addends that equal 0-5.

Day 26: Using the TouchMath Addition Kit materials, have the students use manpulatives, pictures, or TouchPoints to complete and solve horizontal and vertical addition problems that have three addends that equal 0-5.

Day 27: Using the TouchMath Addition Kit materials, have the students use manpulatives, pictures, or TouchPoints to complete and solve horizontal and vertical addition problems that have three addends that equal 0-8.

Day 28: Using the TouchMath Addition Kit materials, have the students use manpulatives, pictures, or TouchPoints to complete and solve horizontal and vertical addition problems that have three addends that equal 0-10.

Day 29: Using the TouchMath Addition Kit materials, have the students use manpulatives, pictures, or TouchPoints to complete and solve horizontal and vertical addition problems that have three addends that equal 0-10.

Day 30: Give the students the posttest.

Appendix C

Traditional Lesson Plans

Day 1: Introduce the number 1 to the students. Show them the number and how to write it. Give the students a piece of paper and have them practice writing the number 1.

Day 2: For morning work, have the students practice writing the number that was introduced the previous day. During math instruction, introduce the number 2 to the students. Show them the number and how to write it. Give the students a worksheet to trace the number and independently write the number.

Day 3: For morning work, have the students practice writing the number that was introduced the previous day. During math instruction, introduce the number 3 to the students. Show them the number and how to write it. Give the students a worksheet to trace the number and independently write the number.

Day 4: For morning work, have the students practice writing the number that was introduced the previous day. During math instruction, introduce the number 4 to the students. Show them the number and how to write it. Give the students a worksheet to trace the number and independently write the number.

Day 5: For morning work, have the students practice writing the number that was introduced the previous day. During math instruction, introduce the number 5 to the students. Show them the number and how to write it. Give the students a worksheet to trace the number and independently write the number.

Day 6: For morning work, have the students practice writing the number that was introduced the previous day. During math instruction, introduce the number 6 to the students. Show them the number and how to write it. Give the students a worksheet to trace the number and independently write the number.

Day 7: For morning work, have the students practice writing the number that was introduced the previous day. During math instruction, introduce the number 7 to the students. Show them the number and how to write it. Give the students a worksheet to trace the number and independently write the number.

Day 8: For morning work, have the students practice writing the number that was introduced the previous day. During math instruction, introduce the number 8 to the students. Show them the number and how to write it. Give the students a worksheet to trace the number and independently write the number.

Day 9: For morning work, have the students practice writing the number that was introduced the previous day. During math instruction, introduce the number 9 to the students. Show them the number and how to write it. Give the students a worksheet to trace the number and independently write the number.

Day 10: For morning work, have the students practice writing the number that was introduced the previous day. During math instruction, introduce the number 10 to the students. Show them the number and how to write it. Give the students a worksheet to trace the number and independently write the number.

Day 11: For morning work, have the students practice writing the number that was introduced the previous day. During math instruction, review the numbers 1-10 with the students. Review how to write each number and have the students write each number 5 times each on a blank piece of paper. Using flashcards, conduct and informal assessment of the student's knowledge of the numbers one through 10.

Day 12: Through direct instruction, tell the students the concept of addition. On chart paper, write five vertical addition problems which sums equal 0-2. Then have the students complete a worksheet with solutions that equal 0-2.

Day 13: Review the concept of addition. Repeat the directions from day 12 directions using sums that equal 0-2.

Day 14: Through direct instruction, write five addition problems on chart paper and show the students how to solve the problems that equal 0-3. Then have the students complete a worksheet with solutions that equal 0-3.

Day 15: Repeat the directions from day 14 directions using sums that equal 0-3.

Day 16: Through direct instruction, write five addition problems on chart paper and show the students how to solve the problems that equal 0-4. Then have the students complete a worksheet with solutions that equal 0-4.

Day 17: Repeat the directions from day 16 directions using sums that equal 0-4.

Day 18: Through direct instruction, write five addition problems on chart paper and show the students how to solve the problems that equal 0-5. Then have the students complete a worksheet with solutions that equal 0-5.

Day 19: Repeat the directions from day 18 directions using sums that equal 0-5.

Day 20: Assess the students' knowledge of addition problems with sums that equal 0-5.

Day 21: Through direct instruction, write five horizontal addition problems on chart paper and show the students how to solve the problems that equal 0-6. Then have the students complete a worksheet with solutions that equal 0-6.

Day 22: Repeat the directions from day 21 directions using sums that equal 0-6.

Day 23: Through direct instruction, write five horizontal addition problems on chart paper and show the students how to solve the problems that contain 3 addends that equal 0-7. Then have the students complete a worksheet with solutions that equal 0-7.

Day 24: Repeat the directions from day 23 directions using sums that equal 0-7.

Day 25: Through direct instruction, write five horizontal and vertical addition problems on chart paper and show the students how to solve the problems that contain 3 addends that equal 0-8. Then have the students complete a worksheet with solutions that equal 0-8.

Day 26: Repeat the directions from day 25 directions using sums that equal 0-8.

Day 27: Through direct instruction, write horizontal and vertical five addition problems on chart paper and show the students how to solve the problems that contain 3 addends that equal 0-9. Then have the students complete a worksheet with solutions that equal 0-9.

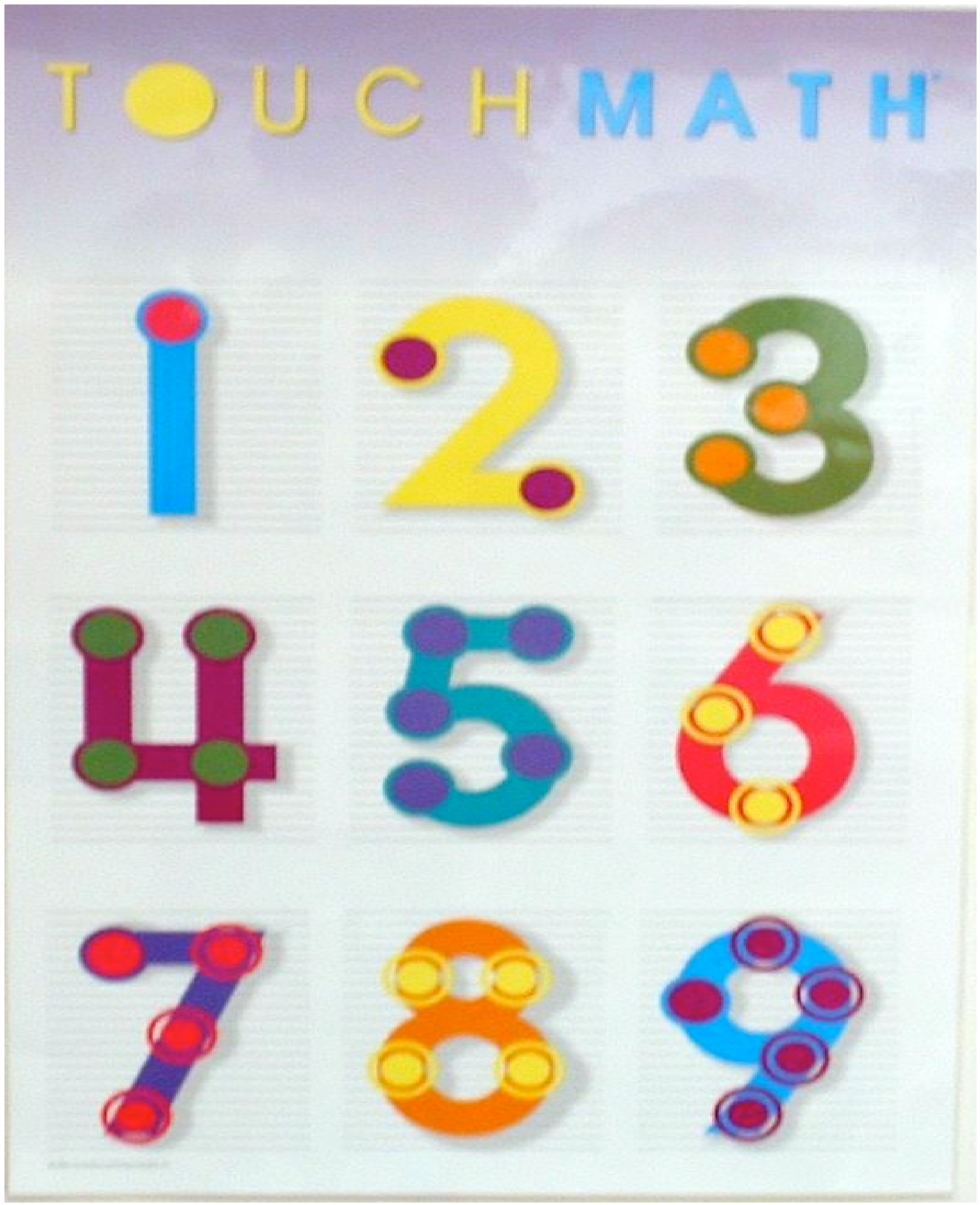
Day 28: Repeat the directions from day 27 directions using sums that equal 0-9.

Day 29: Through direct instruction, write horizontal and vertical five addition problems on chart paper and show the students how to solve the problems that contain 3 addends that equal 0-10. Then have the students complete a worksheet with solutions that equal 0-10.

Day 30: Give the students the posttest.

Appendix D

TouchMath Poster



Appendix E

Confidentiality Agreement

CONFIDENTIALITY AGREEMENT

Name of Signer: Julie Rogers

During the course of my activity in collecting data for this research: *Teaching Mathematics to Kindergarten Students Through a Multisensory Approach*

I will have access to information, which is confidential and should not be disclosed. I acknowledge that the information must remain confidential, and that improper disclosure of confidential information can be damaging to the participant.

By signing this Confidentiality Agreement I acknowledge and agree that:

1. I will not disclose or discuss any confidential information with others, including friends or family.
2. I will not in any way divulge, copy, release, sell, loan, alter or destroy any confidential information except as properly authorized.
3. I will not discuss confidential information where others can overhear the conversation. I understand that it is not acceptable to discuss confidential information even if the participant's name is not used.
4. I will not make any unauthorized transmissions, inquiries, modification or purging of confidential information.
5. I agree that my obligations under this agreement will continue after termination of the job that I will perform.
6. I understand that violation of this agreement will have legal implications.
7. I will only access or use systems or devices I'm officially authorized to access and I will not demonstrate the operation or function of systems or devices to unauthorized individuals.

Signing this document, I acknowledge that I have read the agreement and I agree to comply with all the terms and conditions stated above.

Signature: Julie Rogers **Date:** 11-29-10

Appendix F

Local School Research Request Form

LOCAL SCHOOL RESEARCH REQUEST FORM

Name of School: ABC Elementary School

Name of Researcher: Stephanie Uzomah

Position or Grade: Kindergarten Teacher

A. Research Project Title: Teaching Mathematics to Kindergarten Students Through a Multisensory Approach

b. Statement of Problem: There is a problem in the academic achievement at ABC Elementary School, in Gwinnett County, Georgia. The problem is a 55% increase in the number of students who did not meet the minimal requirements between the 2004-2005 and 2005-2006 school years on the first grade mathematics section of the Criterion-Reference Competency Test (CRCT) (U.S. Department of Education, 2007). Studies also showed 68% percent of fourth-grade students in Georgia are meeting the minimum standards on state mandated tests (U.S. Department of Education, 2007). These deficits in math achievement, coupled with the stricter educational requirements and standards established by the NCLB, are a concern to educators in Georgia and at ABC Elementary School. Early childhood educators are trying to find a balance between developmentally appropriate practices and the required achievement benchmarks identified by NCLB (U.S. Department of Education, 2007).

c. Research Question: Is there a difference in computational abilities between kindergarten students taught by the TouchMath program and those taught through traditional means?

d. Subjects or population for the study: The population will consist of six kindergarten classrooms with approximately 16 students in each class at ABC Elementary School**.**

e. Reason for doing this research:

____X______Graduate Study at Walden University
__________Publication/Presentation
__________Other (please specify) ____

f. Dates research will be conducted: _______________ to ______________________

B. All research and researchers must a) Protect the rights and welfare of all human subjects, b) Inform students and/or parents that they have the right not to participate in the study, c) Adhere to board policies and applicable laws which govern the privacy and confidentiality of students records.

C. This request applies to research conducted within and by local school personnel. All other research requests must be submitted to the Research & Evaluation Office according to the GCPS Research Proposal Format.

D. Principals ONLY need to approve Local School Research Requests. The copy sent to the Research & Evaluation Office is for filing purposes only. No further approval is necessary.

E. After approval by the principal, please forward a copy of this completed form to:

Via GCPS Courier:
Colin Martin
GCPS - Research & Evaluation
ISC

Via US Mail:
Dr. Colin Martin, Executive Director
Research & Evaluation Office
Gwinnett County Public Schools
437 Old Peachtree Road, NW
Suwanee, GA 30024

Via Fax:
Colin Martin
678-301-7088

______________________________ 12/03/10

Principal's Signature **Date of Approval**

Appendix G

Data Usage Agreement

DATA USE AGREEMENT

This Data Use Agreement effective as of January 2011, is entered into by and between Stephanie Uzomah and McKendree Elementary School. The purpose of this Agreement is to provide Data Recipient with access to a Limited Data Set ("LDS") for use in research in accord with the HIPAA and FERPA Regulations.

1. Definitions. Unless otherwise specified in this Agreement, all capitalized terms used in this Agreement not otherwise defined have the meaning established for purposes of the "HIPAA Regulations" codified at Title 45 parts 160 through 164 of the United States Code of Federal Regulations, as amended from time to time.

2. Preparation of the LDS. Stephanie Uzomah shall prepare and furnish to Data Recipient a LDS in accord with any applicable HIPAA or FERPA Regulations

3. Data Fields in the LDS. No direct identifiers such as names may be included in the Limited Data Set (LDS). In preparing the LDS, Stephanie Uzomah shall include the **data fields specified as follows**, which are the minimum necessary to accomplish the research: a Horcourt (2004) pre and post test.

4. Responsibilities of Data Recipient. Data Recipient agrees to:

   a. Use or disclose the LDS only as permitted by this Agreement or as required by law;

   b. Use appropriate safeguards to prevent use or disclosure of the LDS other than as permitted by this Agreement or required by law;

   c. Report to Data Provider any use or disclosure of the LDS of which it becomes aware that is not permitted by this Agreement or required by law;

   d. Require any of its subcontractors or agents that receive or have access to the LDS to agree to the same restrictions and conditions on the use and/or disclosure of the LDS that apply to Data Recipient under this Agreement; and

   e. Not use the information in the LDS to identify or contact the individuals who are data subjects.

5. Permitted Uses and Disclosures of the LDS. Data Recipient may use and/or disclose the LDS for its Research activities only.

6. Term and Termination.

   a. Term. The term of this Agreement shall commence as of the Effective Date and shall continue for so long as Data Recipient retains the LDS, unless sooner terminated as set forth in this Agreement.

   b. Termination by Data Recipient. Data Recipient may terminate this agreement at any time by notifying the Data Provider and returning or destroying the LDS.

   c. Termination by Data Provider. Data Provider may terminate this agreement at any time by providing thirty (30) days prior written notice to Data Recipient.

   d. For Breach. Data Provider shall provide written notice to Data Recipient within ten (10) days of any determination that Data Recipient has breached a material term of this Agreement. Data Provider shall afford Data Recipient an opportunity to cure said alleged material breach upon mutually agreeable terms. Failure to agree on mutually agreeable terms for cure within thirty (30) days shall be grounds for the immediate termination of this Agreement by Data Provider.

   e. Effect of Termination. Sections 1, 4, 5, 6(e) and 7 of this Agreement shall survive any termination of this Agreement under subsections c or d.

7. Miscellaneous.

   a. Change in Law. The parties agree to negotiate in good faith to amend this Agreement to comport with changes in federal law that materially alter either or both parties' obligations under this Agreement. Provided however, that if the parties are unable to agree to mutually acceptable amendment(s) by the compliance date of the change in applicable law or regulations, either Party may terminate this Agreement as provided in section 6.

   b. Construction of Terms. The terms of this Agreement shall be construed to give effect to applicable federal interpretative guidance regarding the HIPAA Regulations.

   c. No Third Party Beneficiaries. Nothing in this Agreement shall confer upon any person other than the parties and their respective successors or assigns, any rights, remedies, obligations, or liabilities whatsoever.

   d. Counterparts. This Agreement may be executed in one or more counterparts, each of which shall be deemed an original, but all of which together shall constitute one and the same instrument.

e. Headings. The headings and other captions in this Agreement are for convenience and reference only and shall not be used in interpreting, construing or enforcing any of the provisions of this Agreement.

IN WITNESS WHEREOF, each of the undersigned has caused this Agreement to be duly executed in its name and on its behalf.

DATA PROVIDER	**DATA RECIPIENT**
Signed: Stephanie Uzomah	Signed: Loretta Denmark
Print Name: Stephanie Uzomah	Print Name: Loretta Denmark
Print Title: Reseracher	Print Title: Principal