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The Impact of Differentiated Versus Traditional Instruction on Math Achievement and Student Attitudes

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COLLEGE OF EDUCATION

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MEd Bowling Green State University, 1992

BA Ashland College, 1983

Doctoral Study Submitted in Partial Fulfillment

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Doctor of Education

Teacher Leadership

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Abstract

With the implementation of the No Child Left Behind (NCLB), all schools are held accountable for student achievement. One southern US Title I school failed to meet NCLB mandated math standards for several years and was placed on program improvement. The purpose of this study was to compare math achievement of 34 students in fifth grade using differentiated instruction via Math out of the Box (MOOTB) and math achievement of 34 students in fifth grade using traditional textbook instruction. A second purpose was to determine if there was a difference between student attitudes toward math relative to confidence, value, enjoyment, and motivation. The theoretical base for this study is rooted in the works of Gardner's theory of multiple intelligences, Vygotsky's sociocultural theory, Bruner's psychological theory, Piaget's concrete operational theory, and Tomlinson's differentiated instruction theory. In order to examine the differences in math achievement based on the two instructional approaches, a quasi-experimental nonequivalent (pretest-posttest) control group design was implemented with scores analyzed using the one-way analysis of covariance. The univariate analysis of variance was used to compare the differences between MOOTB and traditional fifth grade students' attitudes toward math relative to confidence, value, enjoyment, and motivation. The findings from the study showed improvements in both instructional groups on MAP posttest, but differences between the groups on math scores were not significant. The main effect for socioeconomic status was significant. A significant difference in students' attitudes toward math relative to enjoyment was noted. This study has the potential to provide school systems with alternative ways to increase student achievement which is an important implication for social change.

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Dedication

This doctoral study is dedicated to God who has given me the strength to believe in myself when I had doubt and to press on to the finish line and not give up." For God has not given us a spirit of fear, but of power and of love and of a sound mind" (II Timothy 1:7). I want to dedicate this doctoral study to my husband, Kenneth Joe Gamble, who believed in me from the moment I started this project. My husband has been there for me when the times got rough. His love, understanding, and inspiration helped me accomplish so much. I will be forever grateful for all he has done during the numerous hours spent on this project. I want to thank my sons, DeWayne and Kevin, and my daughter, LaKendra, for your love and kindness. I want to dedicate this doctoral study in loving memory of my mother, Evelyn McNeil Burts, who instilled in me the importance of education and provided me with a strong educational foundation. I want to thank my sister, Vicky, for all her words of encouragement and love and for lending an ear when I needed to vent. I want to thank my other siblings, Crystal, Holly, and Mark, for their love and support.

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Section 1: Introduction to the Study

In education, the current trend is to focus on student achievement in an effort to raise test scores and improve the level of instruction in the classroom. In 2002, President Bush signed into law the No Child Left Behind Act (NCLB) of 2001, which was designed to set compulsory levels of achievement based on standardized test scores. The focus of NCLB is on improving achievement, teacher training, and school accountability (U. S. Department of Education, 2001). The following are goals of the NCLB Act:

1. All students are to reach high standards and attain proficiency or better in reading and math by 2014.
2. All limited English proficient students will become proficient in English.
3. Highly qualified teachers will teach all students by 2006.
4. All students will be educated in learning environment that are safe, drug free, and conducive to learning (U.S. Department of Education, 2001).

The NCLB Act (2001) reauthorized several federal programs such as supplemental services whose purpose was to improve the performance of primary and secondary schools by raising standards and providing parents with flexibility in choosing a school that would be the best fit for their children. The NCLB Act requires states to develop challenging content and performance standards and to implement basic skill assessments that measure how well students perform to those standards. The NCLB Act also requires that administrators, teachers, and parents ensure that all students are achieving to their maximum potential (U.S. Department of Education, 2001). According to George (2005), the NCLB Act has the potential to change the education in the United

States; however, the vision of this act is an impossible task if educators continue to hold on to the same teaching practices.

Adequately Yearly Progress (AYP) measures the performance of schools based on standardized tests and highlights those individual schools needing improvements (Goetz, 2001). Students must score in the proficient and advanced levels in order to meet AYP within an appropriate timeframe (Goertz, 2001). With the new federal requirements for AYP, schools that fail to meet AYP go through a progression of steps in order to improve test scores and meet accountability standards. These steps include additional teacher training, tutoring for students, staff development, redesigning classrooms, and extensive teacher evaluations (Goertz, 2001).

Testing has become a central part in promoting the academic success of students. Society has begun to consider good test scores as a major goal of schooling (Tomlinson, 2008). In response to the emphasis on test scores, teachers need to examine several important aspects of classroom practices (Tomlinson, 2008). Teachers also need to observe what strategies engage students and what strategies do not (Tomlinson, 2008).

One strategy that helps to engage students is differentiated instruction. Differentiated instruction is a teaching philosophy that gives children multiple ways of taking in information and expressing what they have learned (Hall, 2005). Tomlinson, an educator with 21 years of experience in the public school sector, has worked as a public administrator of special services for struggling and advanced learners. Tomlinson is also an expert in the field of differentiated instruction. Tomlinson (1999) stated, “Even though students may learn in many ways, the essential skills and content they learn can remain steady. That is, students can take different roads to the same destination" (p. 12). An effective way is through a differentiated approach to learning (Tomlinson, 2001).

Tomlinson (2003) defined differentiating instruction by stating the following:

> Differentiated instruction is that a teacher proactively plans varied approaches to what students need to learn, how they will learn it, and/or how they can express what they have learned in order to increase the likelihood that each student will learn as much as he or she can as efficiently as possible (p.151). When teachers

plan effectively, students receive quality instruction that will help them learn, grow, and succeed.

Statement of the Problem

At an urban Title I school, located in a southern state, there is a problem that affects students in mixed ability classrooms. That problem is that students have failed to meet accountability standards for several years. Currently, the NCLB Act, designed to set compulsory levels of achievement based on standardized test scores, and the new federal requirement of AYP require that all schools meet accountability standards (U.S. Department of Education, 2001). In this southern state, students in Grades 3 through 6 are tested in language arts, mathematics, science, and social studies. The scoring level categories are not meeting standards, meeting standards, or exemplary.

AYP is based on the percentage of students scoring in the proficient and advanced levels in mathematics and reading. Proficient is equivalent to meeting standards and advanced is equivalent to exemplary. This southern Title I school, has failed to meet AYP from 2002 through 2007. The mathematic scores from the Palmetto Achievement Challenge Test (PACT) for fifth grade students are listed in the following table.

Table 1

Fifth Grade PACT scores from 2002-2007

Year	Proficient	Advanced
2002	19.3	8.3
2003	21.1	13.5
2004	13.4	8.8
2005	13.6	10.1
2006	14.7	7.3
2007	12.2	3.0

Table 1 shows the percentages of fifth grade students who scored proficient and advanced on PACT from 2002 through 2007.

Based on scores from the PACT, this Title I school has failed to meet accountability standards for several years. The school now faces program improvement along with school choice for students. School choice means that parents can select a school they want their child to attend. Failing to meet accountability standards affect all students, especially low-achieving students because they continue to fall behind and continue to score low on achievement tests (Barton, 2004).

This study will contribute to the body of knowledge needed to address this problem by looking at the impact on math achievement using Math Out of the Box (MOOTB) versus using the traditional textbook. MOOTB is an inquiry-based math curriculum centered on how children learn (Moss, 2005). Using a differentiated approach to teaching math via MOOTB, the researcher hoped to see if fifth-grade students within mixed ability classrooms make significant gains in math based on their Measures of Academic Progress (MAP) test results.

MAP is a computerized test that measures ongoing academic progress. MAP data are used to guide teachers by pinpointing specific strengths and weaknesses in both individual students and groups of students. Student results from MAP data are used by teachers for guiding and planning instruction in meeting the needs of all learners.

The independent variable in this study is the differentiated instruction via MOOTB. The dependent variables of the study are the scores from the students' MAP tests and students' attitudes. The constant variable in this study is the grade level.

Research Questions and Hypotheses

The research questions are as follows:

1. Is there a difference in math achievement of fifth grade students who were taught using MOOTB and the math achievement of fifth grade students taught traditionally?

2. Is there a difference in math achievement of fifth grade students who were taught using MOOTB and the math achievement of fifth grade students taught traditionally based on race?

3. Is there a difference in math achievement of fifth grade students who were taught using MOOTB and the math achievement of fifth grade students taught traditionally based on socioeconomic status?

4. Is there a difference in math achievement of fifth grade students who were taught using MOOTB and the math achievement of fifth grade students taught traditionally based on gender?

5. Is there a significant difference between MOOTB and fifth grade students' attitude toward math and traditional fifth grade students' attitude toward math relative to confidence, value, enjoyment, and motivation?

It is predicted that the implementation of MOOTB and differentiated instruction strategies in the classroom will show an increase in students' math performance.

Null and Alternative Hypotheses

Ho1: There is no statistically significant difference in math achievement of fifth grade students, as measured by MAP test scores between students taught using MOOTB and fifth grade students using traditional textbooks.

Ha: There is a statistically significant difference in math achievement of fifth grade students, as measured by MAP test scores between students taught using MOOTB and fifth grade students using traditional textbooks.

Ho2: There is no significant difference in math achievement of fifth grade students as measured by MAP test scores between students taught using MOOTB and fifth grade students taught using traditional textbooks based on race.

Ha: There is a statistically significant difference in math achievement of fifth grade students, as measured by MAP test scores between students taught using MOOTB and fifth grade students taught using traditional textbooks based on race.

Ho3: There is no significant difference in math achievement of fifth grade students as measured by MAP test scores between students taught using MOOTB and fifth grade students taught using traditional textbooks based on gender.

Ha: There is a significant difference in math achievement of fifth grade students as measured by MAP test scores between students taught using MOOTB and fifth grade students taught using traditional textbooks based on gender.

Ho4: There is no significant difference in math achievement of fifth grade students as measured by MAP test scores between students taught using MOOTB and fifth grade students taught using traditional textbooks based on socioeconomic status.

Ha: There is a significant difference in math achievement of fifth grade students as measured by MAP test scores between students taught using MOOTB and fifth grade students taught using traditional textbooks based on socioeconomic status.

Ho5: There is no significant difference between MOOTB and fifth grade students' attitude toward math and traditional fifth grade students' attitude toward math relative to confidence, value, enjoyment, and motivation.

Ha: There is a significant difference between MOOTB and fifth grade students' attitude toward math and traditional fifth grade students' attitude toward math relative to confidence, value, enjoyment, and motivation.

Purpose of the Study

The purpose of this quantitative study was to determine if there was a significant difference in math achievement of fifth grade students taught using MOOTB and fifth grade students taught traditionally. A second purpose of this quantitative study was to determine if there was a significant difference between MOOTB fifth grade students' attitude toward math and traditional fifth grade students' attitude toward math relative to confidence, value, enjoyment, and motivation.

Theoretical Base

The theoretical base for this study is rooted in the works of Gardner (2004), Vygotsky (2001), Bruner (2004), Piaget (1970), and Tomlinson (2001). Gardner is known for his theory on multiple intelligences. Gardner identified eight multiple intelligences: word smart or linguistic and verbal, music smart or musical, logic smart or mathematical-logical, picture smart or spatial, body smart or bodily-kinesthetic, people smart or interpersonal, self- smart or intrapersonal, and nature smart or environmental or naturalist. Gardner believed that when teachers know how students learn and at what intellectual level, teachers can better instruct students' individual needs.

Using MOOTB as it relates to Gardner's (2004) theory allows the researcher to accommodate for each child's intelligence. For example, the use of manipulatives accommodates those children who learn best through visual-spatial and kinesthetic. Using MOOTB allows children to explore and learn through touching and movement.

The assessment methods from MOOTB, such as class discussions, teacher observations, individual and group questioning, making connections, and sharing mathematical thinking take into account the diversity of intelligences, as well as self-assessment tools that help students understand their intelligences (Funderstanding, para 4, 2005). Asking open-ended questions allow students to apply their new knowledge and the teacher to asses the learning that is taking place. There are several open-ended questions embedded in the MOOTB curriculum in which the teacher can assess the learning that has taken place.

Vygotsky's (1993) sociocultural theory is based on social aspects of learning. According to Vygotsky, children learn by working together as well as developing concepts by using concrete objects to construct meaning. Vygotsky's zone of proximal development receives high recognition from teachers and other theorists (Byrnes, 2001). The zone of proximal development is the gap between what a learner has already mastered (actual level of development) and what he or she can achieve (potential development) when provided with the educational support (Vygotsky, 1993).

Using MOOTB allows children to work together where they can communicate ideas and explain their understanding from their own perspectives. Using MOOTB also allows children to use concrete objects such as manipulative, measuring cups, analog clocks, three-dimensional shapes, and many more tangible objects that help children understand the concept they are learning (Moss, 2005). Eventually, students will surpass the use of manipulatives and solve problems through abstract thinking, writing, and using a calculator (Vygotsky, 1993).

Bruner's (2004) psychological theory of learning states that children's thinking is focused on concrete properties that could be actively manipulated. Bruner called for the use of concrete objects in instruction, suggesting that the use of many concrete objects could help move children beyond their focus of the perceptual properties of the individual object.

MOOTB has several concrete objects embedded in the lessons. For example, children use a trundle wheel, a measuring tool used by surveyors, asphalt companies, landscapers, and other professionals to measure distances. Another example of using concrete objects through MOOTB is the use of a pedometer, a device that measures step count by recording the vertical movement of the body. Using the pedometer, children can calculate their step count. The use of concrete objects helps children understand and make their learning clearer (Clemson University, 2005).

In using MOOTB, as it relates to Bruner's (2004) theory, children take ownership because they are in control of their learning. For example, in a lesson focusing on patterns, children can create movements that represent patterns. They also discuss many different ways in which steps make a pattern and develop rules of extending the pattern (Clemson University, 2005). Using MOOTB allows the researcher to vary teaching strategies, which can assist students with learning and developing study skills. Successful strategies include work stations, compacting, agendas, and complex instruction. These strategies are embedded in the MOOTB curriculum.

Piaget's (1970) theory focuses on children's thinking being concrete. Children move through stages from concrete to abstract. Piaget developed three principles:

1. Students must internalize action schemes by performing mental computations.
2. Thinking at each developmental level is considered.
3. In order for children to move ahead in their thought processes, teachers must Provide them with ideas for later use, and alternative ways in which children can grasp information.

Tomlinson (2001) discussed the importance of differentiating instruction. Teachers who differentiate instruction rely on a number of strategies to accommodate the diversity of academic needs of all children (Tomlinson, 2001). Tomlinson stated that children of the same age learn differently because they are not alike. Children do have things in common but have important differences. It is how they differ that makes them unique (Tomlinson, 2001). "In a classroom with little or no differentiated instruction, only student similarities seem to take center stage" (Tomlinson, 2001, p. 1). Students do not have the opportunities to express or share ideas or make plans for additional investigation (Tomlinson, 2001). It is important to construct classrooms so that children can learn independently and in cooperative groups with others who have demonstrated mastery.

Tomlinson's (2001) theory relates to this study because MOOTB and differentiating instruction provide a solid format for learning. MOOTB relies on a number of strategies to deliver instruction and this instruction meets the needs of diverse learners. MOOTB curriculum provides multiple assessment options.

Definition of Terms

The following are key concepts or terms important to the study.

Adequate yearly progress (AYP): AYP is designed to highlight schools needing improvement. Schools must meet their target goal in order to meet AYP (U.S. Department of Education, 2001).

Apply: the application phase of the learning cycle challenges students to apply their knowledge to real-world situations, make connections to past learning and new knowledge. In this phase, the gathered information comes together. Ideas, patterns, and concepts make sense, and students are more likely to retain these concepts because they understand how these connections come together (Moss, 2005).

Differentiating content: content is "the 'input' of teaching and learning. It's what we teach or what we want students to learn" (Tomlinson, 2001, p. 72). It means giving students access to skills and knowledge (Willis & Mann, 2000).

Differentiating instruction: differentiating instruction means delivering instruction in "ways that meet the needs of auditory, visual, and kinesthetic learners" (Mann & Willis, 2000, para. 1). It is a clear and solid method to modify instruction. It is also a teaching philosophy that means "shaking up" and that allows students to have multiple options for taking in information, making sense of ideas, and expressing what they learn (Mann & Willis, 2000).

Differentiating process: differentiating process means sense-making. This provides students with an opportunity to process what they learn (Tomlinson, 2001).

Differentiating products: differentiating product is demonstrating and extending what has been learned. It is applying learning beyond the classroom (Tomlinson, 2001).

Engage: the engaging phase of the learning cycle gets the students motivated in learning. It allows students to make connections between past and present-learning experiences. It also provides a preassessment opportunity for the teacher and the student (Moss, 2005).

Flexible grouping: the grouping of students according to their interests, readiness, and learning profile (Tomlinson, 2001).

Gender: is defined in terms of male and female categories as designated by district school reports (County Report Card, 2010).

Investigate: the investigating phase of the learning cycle gives students concrete experiences that challenge them in solving problems. Students gather information, observe and analyze patterns, make connections and draw and defend conclusions verbally and in writing (Moss, 2005).

Learning cycle: MOOTB uses a learning cycle, which is developed around how children learn. The learning cycle connects mathematical concepts throughout the learning process. The learning cycle also includes four phases (Moss, 2005).

Learning styles: learning styles refer to the way an individual thinks and processes information (Kolb, 1983). It is also described as being cognitive, affective, and psychological behaviors that explain why students act in a certain way. These behaviors are indicators of “how the learners perceive, interact with, and respond to the learning environment” (Brent & Felder, 2005, p.2).

Math achievement: refers to using researched-based teaching methods to ensure that all students can show mastery of grade level skills being taught (Byrnes, 2001). In this study, math achievement is measured using MAP data and compares MOOTB to non-MOOTB classrooms.

Math Out of the Box (MOOTB): is an inquiry-based, standards–based, and research-based mathematics curriculum for grades kindergarten through fifth grade that allow students to communicate their learning in different ways (Moss, 2005).

Measures of Academic Progress (MAP): MAP is a computerized assessment that helps teachers improve learning and teaching. Students may be tested four times a year. Test results help teachers target areas of need and a great tool to use in planning for school improvement (Northwest Evaluation Association, NWEA).

Multiple intelligence: multiple intelligence is a theory in which a teacher recognizes individual differences, and instructs students according to their differences (Gardner, 2004).

No Child Left Behind Act (NCLB) Act: NCLB was designed to "improve student achievement and change the culture of America's schools" (U.S. Department of Education, 2001, para.1).

Race: Race is defined in terms of racial groups of students assigned according to this school. For purposes of this study, the racial groups are composed of Black, White, Hispanic, and Asian (County Report Card, 2010).

Reflect: the reflecting phase of the learning cycle is where students think about what they have learned and how they learned it. Students communicate their findings by sharing ideas in a variety of ways and making connections to what was learned with what they already know. Students take ownership of new knowledge (Moss, 2005).

Socioeconomic status: is based on low (under $25,000), middle ($25,000 and above), and high ($40,000 and above) family income (County Report Card, 2010).

Title I: the goal of Title I is to help all children receive a high-quality education. Title I provides resources from the federal government that are directed towards students who need them the most. Funding is determined by the percentage of students receiving free and reduced lunch (U.S. Department of Education, 2001).

Traditional teaching: Teaching is unitary. Whole class instruction dominates (Tomlinson, 2001).

Assumptions, Limitations, and Delimitations

Assumptions

1. The MAP testing environment was administered in the same testing area for all students (MOOTB and non-MOOTB instruction).
2. Students' scores were not counted if their attendance fell below the average

attendance for the class.

3. MAP scores taken prior to and after the study were used for both groups.
4. Some students were more involved, more motivated, and cared more about their achievement than others. It is assumed that, controlling for achievement, students who were motivated, on task, and involved in the lessons showed greater gains in their MAP scores than those students who appeared to be off task at times and not motivated.
5. The research conducted cannot assume to provide information in subject areas other than math.

Limitations

1. Implementing MOOTB and not following the storyline or applying strategies could skew the results.
2. The accuracy of the results in student responses concerning whether they enjoyed the differentiated instruction via MOOTB versus traditional textbook instruction is contingent upon the information supplied by the respondents.

Delimitations

1. The study was conducted between November of 2010 and January of 2011.
2. The study was limited to only fifth grade students enrolled in one urban school in a Southern state.
3. The quasi-experimental, quantitative method, with a nonequivalent (pretest-posttest) design involved students in the fifth grade at an urban elementary school located in a southern state. The research was conducted at the southern state elementary school. The students from four fifth grade classes were the sources of

data collection. Two classes received differentiated instruction using MOOTB, and two classes received traditional textbook instruction. Data include pre and posttest assessments from MAP scores and student survey responses.

Significance

Math Out of the Box is a standards-based, researched-based, and inquiry-based approach to teaching mathematics (Moss, 2005). The goal of the program is "to fulfill the mathematical promise that exists in every child by providing teachers with innovative materials, a mathematically challenging curriculum, and high quality professional development" (Moss, p. 1). The MOOTB curriculum has four strands, which are Algebraic Thinking, Geometric Logic, Measurements, and Number Concepts. All of these strands provide a comprehensive math curriculum that supports the mathematical development of all students (Moss, 2005). The curriculum is designed so that students will develop and make connections that are meaningful to them (Moss, 2005).

The significance of using MOOTB in this research study is that it may provide a new way of teaching mathematics through a differentiated approach to learning. It will promote social change by improving student achievement for all learners within a mixed ability classroom. Because there are limited schools using MOOTB, the researcher hopes to show significant gains in student achievement through a differentiated approach to learning and more schools would be willing to adopt the program. This study may provide a better understanding of the effectiveness of differentiated instruction teaching model using MOOTB within mixed ability classrooms.

Summary

According to Wilkins, Wilkins, and Oliver (2006), Brent and Felder (2005), and Gardner (2007), teachers must adjust their instructional strategies and equip students with the necessary skills that encompass all types of learning. When teachers recognize student differences and make accommodations, they provide a rich environment that is beneficial to all students.

Using a differentiated approach to teaching mathematics via MOOTB may change the way mathematics is taught. It may help students grow emotionally and socially because students are working cooperatively, collaboratively, and independently (Moss, 2005). It provides them with sound experiences that are challenging, encouraging, and interesting (Tomlinson, 2001; Moss, 2005). Students can express what they are learning verbally and in writing (Moss, 2005).

This quantitative method study compared the effectiveness of differentiated instruction via MOOTB and traditional textbook instruction on student achievement. The quantitative section of this research study also determined if there was a significant difference between MOOTB fifth grade students' attitude toward math and traditional fifth grade students' attitude toward math relative to confidence, value, enjoyment, and motivation.

Section 1 introduced the study, problem statement, and variables. The nature of the study, specific research questions, and hypotheses were also stated and described. The purpose of the study, theoretical base, and definition of terms were established. Section 2 includes a review of the related research. Section 3 presents the research design and methodology. Section 4 presents the findings. The study concludes with section 5, which provides an overview of the study, findings, implications for social change, recommendations for action and further study.

Section 2: Literature Review

Introduction

Brain research confirms that no two children are alike and that children do not learn in the same way (Guskey, 2007). Children should be taught so they can think for themselves (Guskey, 2007). According to Tomlinson (2001), many teachers struggle in finding ways to reach individual students primarily because students learn in a variety of ways. Tomlinson, an expert in the field of differentiated instruction, states that differentiated instruction “offers several avenues to learning” (p. 2). The purpose of this research study was to test the effects of teaching math through a differentiated approach (MOOTB) versus traditional textbook on student achievement, and also to determine if there is a difference in attitudes toward math of fifth grade students taught by MOOTB and the attitudes toward math of fifth grade students taught traditionally.

In this chapter, a review of the relevant literature establishes the basis of the study on differentiated instruction using an inquiry-based approach (MOOTB) to teaching math versus a non-differentiated approach (traditional textbook). The literature obtained in this study was retrieved from educational leadership journals such as journal articles from *Education Next* and *Education Week*; and *Basic Books*. Primary sources related to differentiated instruction and MOOTB were found through online databases such as, Educational Resource Information Center (ERIC) and ProQuest using the key words differentiated instruction and MOOTB. An extensive search of articles retrieved from the Internet included reviewed journals and texts on dissertations and research design provided by Walden University, the Walden library, and the community library.

In addition, the chapter also presents the benefits and challenges of differentiated instruction, the advantages and disadvantages of differentiated instruction, a traditional classroom versus a differentiated classroom, and virtual and concrete manipulatives. Secondly, the importance of using MOOTB, the works of learning theorists (Gardner, Piaget, Vygotsky, and Bruner), how MOOTB is different from other inquiry-based programs, benefits of MOOTB, and studies of MOOTB are discussed. The literature review also presents several factors that affect student achievement and achievement gains in MOOTB. Finally, this section concludes with an overall summary of the literature.

Benefits and Challenges of Differentiated Instruction

Differentiated Instruction Defined

Differentiated instruction is essential to student success (Wilkins & Oliver, 2006). Today, classrooms have such a diverse population and it is imperative that teachers modify instruction in order to meet the needs of all learners (Sherman, 2007).

There are many ways to define differentiating instruction. According to Hall (2005), differentiating instruction is helping students learn and develop products effectively. According to Tomlinson (2004), differentiating instruction is “ensuring that what a student learns, how he/she learns it, and how the student demonstrates what he/she has learned is a match for that student’s readiness level, interests, and preferred mode of learning” (p. 188). To meet the demands of such a diverse group of students, teachers work as a catalyst trying to bring about positive results from students (Tomlinson, 2004). Teachers are professionally responsible for the learning of their students (Tomlinson, 2004). Differentiating instruction is an opportunity for young children to share what they have learned and take responsibility for their learning (Tomlinson, 2001, p. 189).

According to Mann and Willis (2000) and Tomlinson (2006), differentiating instruction is a manageable way of meeting individual needs. It is based on how children learn and teachers must adapt to individual learning needs. Mann and Willis (2000) continued defining differentiating instruction as a clear and solid method to modify instruction. According to Mann and Willis (2000), differentiating instruction is also a teaching philosophy that means "shaking up" allowing students to have multiple options for taking in information, making sense of ideas, and expressing what they learn. Mann and Willis (2000) stated that most teachers agree it is better to differentiate instruction, but the challenge lies in translating that belief into action.

> Differentiating instruction means creating multiple paths so that students of different abilities, interest or learning needs experience equally appropriate ways to absorb, use, develop and present concepts as a part of the daily learning process. It allows students to take greater responsibility and ownership for their own learning, and provides opportunities for peer teaching and cooperative learning. (Diamond, 2004, p. 1)

Tomlinson (2001) discussed three components (content, process, and product) that are effective in differentiating instruction. First, differentiated content is teaching and learning. It is what we want our children to learn. In doing this, we can adapt what we teach and modify instruction (Tomlinson, 2001). An example of differentiating content is having students work on fractions while others are working on mastering their multiplication facts (Tomlinson, 2001). In doing so, the teacher has differentiated what the students are learning. Tomlinson further stated that content differentiation is based on students' readiness level and how they learn.

Readiness differentiation of content is matching the material to the students' readiness level (Tomlinson, 2001). For example, it would be a waste of time having a student who has already mastered his or her multiplication facts, complete a worksheet that contains only basic facts (Tomlinson, 2001). According to Tomlinson, student learning should be at an appropriate challenging level for that individual.

Interest differentiation of content involves using materials that build on the individual interest (Tomlinson, 2001). An example of interest differentiation would be allowing a student who is interested in finance to research different banking opportunities or read books dealing with finance (Tomlinson, 2001).

Learning profile differentiation of content is ensuring that students gain knowledge by their preferred way of learning (Tomlinson, 2001). Learning profile differentiation means allowing students who need silence while working that opportunity. During lectures, the teacher can use visuals or transparencies in order to help link visuals to the talk. As Tomlinson stated, "differentiating instruction is so powerful because it focuses on concepts and principles instead of predominantly on facts" (p. 74). Some strategies for differentiating content would be using learning contracts, minilessons, note-taking organizers, highlighted print materials, and peer and adult mentors (Tomlinson, 2001).

Differentiating process means allowing students an opportunity to process the content and skills introduced so they can make sense of the material before they can actually own it (Tomlinson, 2001). Tomlinson further stated that differentiating process according to student readiness means matching the complexity of a task to a student's current level of understanding and skill. Differentiating process according to student interest involves giving students choices about facets of a topic in which to specialize or helping them link a personal interest to a sense-making goal (Tomlinson, 2001). According to Tomlinson (2001), differentiating process generally means allowing students to learn according to their own preferred method being spatially, verbally, or kinesthetically. Differentiating process also means allowing students to make decisions about their learning. Students can decide to work alone versus working with a partner, or sitting on the floor to do work versus sitting in a chair.

Differentiating products represents the students understanding and application (Tomlinson, 2001). Differentiating product assignments help students to rethink, use, and extend what they have learned for a long time (Tomlinson, 2001). Students can show their understanding better from a product rather than taking a written test (Tomlinson, 2001).This is accomplished by replacing a written test with a product assignment in which the student can think about, apply, and demonstrate what they have learned (Tomlinson, 2003). The product could be writing an essay, designing an experiment, developing an exhibit, and so on. Differentiating products work well with struggling learners as well as the advanced learners because students work in ways that address their own readiness level, interest, and learning modes (Tomlinson, 2003). When differentiating products, the teacher must identify the essentials of the unit or study, determine expectations, identify packaging options (e.g. graphing, charting, poetry), and develop a product assignment that clearly says to the student what you expect them to show and at what level when completing the product (Tomlinson, 2003). Differentiating content, process, and products require teachers to be "crystal clear" in what they are teaching and what they want their students to gain (Mann & Willis, 2000, p. 2).

A teacher who recognizes students' needs, abilities and talents can offer different avenues to learning the content through a variety of activities and assignments (Tomlinson, 2008). The teacher and student communicate a variety of ways so that students can show what and how they know (Tomlinson, 2008). Teachers must account for and build on the students preferred ways of learning even as we help them become successful (Mann & Willis, 2000).

Benefits of Differentiated Instruction

Many educators agree that differentiated instruction is an effective teaching strategy in order to meet the needs of all learners (Mann & Willis, 2000). When used effectively, positive results are achieved for all learners. In fact, differentiated instruction offers benefits.

First, differentiating instruction considers how students learn (George, 2005). According to Kolb (1983), the way an individual thinks and processes information determines a student's learning style. Brent and Felder (2005) described learning styles as cognitive, affective, and psychological behaviors that explain why students act in a certain way. These behaviors are indicators of "how the learners perceive, interact with, and respond to the learning environment" (p. 2). Jensen (2005) stated that in order to accommodate an individual's learning style, teachers must immerse students in a variety of activities that involve all the senses.

Brownfield (1993) explained that knowing how students learn can help teachers to accommodate for individual differences. Accommodating for students' learning styles could lead to improved learning and better academic achievement (Stevenson & Dunn, 2001; Stetson, Stetson & Anderson, 2007). According to Gregory and Chapman (2007), due to a diverse population of students, it is important that once teachers identify a student's learning style, they use that knowledge as a basis for instructing. Gregory and Chapman continued to state that mismatched learning styles lead to student dropouts. Gregory and Chapman stressed that the goal of instruction is to equip students with the necessary skills that encompass all modes of learning. It is important that students realize that in order to function effectively, they need a variety of skills (Gregory & Chapman, 2007).

Secondly, differentiated instruction benefits all students because the teacher and the students are involved in the lessons (Eaton, 2005). For example, the principles guiding each differentiated lesson are as follows:

- Has a definite aim for all students.
- Include the teacher focusing on essential learning and key concepts.
- Involve the teacher in modifying the content, process, and products.
- Involves the teacher and students collaborating in the learning.
- Ensures that all students participate in respectful work.
- Provide choices in the method students will use to demonstrate their understanding of the concepts.
- Include the teacher using flexible grouping according to readiness, interests, and/or learning styles.
- Assessments and instruction are inseparable (Eaton, 2005).

Thirdly, differentiated instruction is a benefit to teachers and students because the teachers are inspired to persevere when they see positive results (Mann & Willis, 2000). Mann and Willis continued by stating that teachers are inspired because the students are more engaged and their progress is evident. Veteran teachers are more energized and more excited when they see students' sense of self-efficacy rising and struggling students finding learning more accessible (Mann & Willis, 2000). According to Mann and Willis, the students are more involved and their progress is evident. Mann and Willis continued to stress that the bright students are no longer bored, and the struggling learners are finding learning more accessible which increases their self-efficacy. Differentiating instruction promotes effective peer-to-peer learning, improves self-esteem, and facilitates an education for future citizenship (George, 2005).

Challenges of Differentiated Instruction

Challenges also exist in a differentiated classroom. "The heartbreaking difficulty in pedagogy, as indeed in medicine and other branches of knowledge that partake at the same time of art and science, is in fact, that the best methods are also the most difficult ones" (Piaget, 1969 as cited in Tomlinson, 2001, p. 32).

Managing a differentiated classroom is not easy. Many teachers are uncertain about how to manage a differentiated classroom (Tomlinson, 2001). This tends to stop them from providing instruction based on their students' interests and needs (Tomlinson, 2001). Teachers have a fear of losing control in student behavior, which is a major obstacle for teachers in managing a flexible classroom (Tomlinson, 2001).

Another challenge to differentiating instruction is that it requires a great deal of preparation. The traditional ground rules change, and there is a new look and feel in the classroom (Tomlinson, 2001). Tomlinson continued to state that, "your students and parents may initially need your help to understand and feel comfortable with the new look and feel of the classroom" (Tomlinson, 2001, p. 39); therefore, teachers need to begin differentiating instruction at a pace in which they feel comfortable (Tomlinson, 2001).

Grading in a differentiated classroom is also another challenge. It is imperative that teachers communicate to parents that the new grading system is based on individual goal setting and how students' progress in meeting their goal (Tomlinson, 2001). In a differentiated classroom, students are "graded against themselves rather than in competition with other students" (Tomlinson, p. 93). According to Tomlinson, "charting and acknowledging the academic growth of individual students in a differentiated classroom can create a dilemma for teachers whose schools still use a traditional report card and grading system" (p. 93). Grading in a differentiated classroom is challenging, but teachers must explain to the students and to the parents how the new system works.

Traditional Classroom Versus Differentiated Classroom

According to Tomlinson (2001), in a classroom where there is no differentiated instruction, students' similarities seem to be at the center. Tomlinson continued to state that in a traditional classroom, teaching and learning is unitary. An example that Tomlinson provided for traditional teaching is having students listen to a story and then requiring them all to draw a picture about what they have learned is the traditional way of teaching. Another example that Tomlinson provided is having students view a video or sit through a lecture to help them understand a topic in science or history. When all students read the same chapters, take the same notes, complete the same lab experiments, and take the same quizzes, they are experiencing the traditional way of teaching and learning (Tomlinson, 2003).

Tomlinson (1999) outlined a traditional classroom as follows:

- Student differences are masked or acted upon when problematic.
- Assessment is most common at the end of learning to see “who got it”.
- A relatively narrow sense of intelligence prevails.
- Student interest is infrequently tapped.
- Relatively few learning profile options are taken into account.
- Whole-class instruction dominates.
- Coverage of texts and curriculum guides drives instruction.
- Single option assignments are the norm.
- Time is relatively inflexible.
- A single text prevails.
- Single interpretations of ideas and events may be sought.
- The teacher directs student behavior.
- The teacher solves problems.
- The teacher provides whole-class standards for grading.
- A single form of assessment is often used (p. 16).

According to Tomlinson (2001), differentiated instruction is proactive, more qualitative than quantitative, rooted in assessment, provides multiple approaches to content, process, and product, student centered, a blend of whole-class, group and individual instruction, and organic. “Learning takes place most effectively in classrooms where knowledge is clearly and powerfully organized, students are highly active in the learning process, assessments are rich and varied, and students feel a sense of safety and connection" (National Council, 1990; Wiggins and McTighe, 1998 as cited in Tomlinson, 2001, p. 8). Effective differentiating means adjusting the nature of an assignment to match the needs of all learners rather than adjusting the quantity of an assignment. Adjusting quantity is generally less effective.

According to Tomlinson (2001), a differentiated classroom included the following:

- Student differences are studied as a basis for planning.
- Assessment is ongoing and diagnostic to understand how to make instruction more responsive to learner need.
- Focus on multiple forms of intelligences is evident.
- Students are frequently guided in making interest-based learning choices.
- Many learning profile options are provided for.
- Many instructional arrangements are used.
- Student readiness, interest, and learning profile shape instruction.
- Multi-option assignments are frequently used.
- Time is used flexibly in accordance with student need.
- Multiple materials are provided.
- Multiple perspectives on ideas and events are routinely sought.
- The teacher facilitates students' skills at becoming more self-reliant learners.
- Students help other students and the teacher solve problems.

- Students work with the teacher to establish both whole-class and individual learning goals.
- Students are assessed in multiple ways (p. 16).

Differentiated instructional strategies serve students at all levels of interest, readiness, and mastery. In order for differentiated instruction to be successful, continuous assessment, frequent grouping and regrouping students, careful attention to the physical environment, and effective classroom management must be in place (Learning Point Associates, 2009).

Cooperative learning is an example of a differentiated instruction strategy. Cooperative learning is a model of teaching which supports student success as children work in a group (Willis, 2007). Cooperative learning provides an outlet of socialization and collaboration (Willis, 2007). Having small groups of students collaborating can ease the fear of those students who might be afraid to respond in a whole group setting due to fear of giving an incorrect answer (Willis, 2007).

Another differentiated strategy is teaching children to their preferred learning method. This is known as Gardner's Multiple Intelligences (Nolen, 2003). The eight intelligences are verbal/linguistic, visual/spatial, mathematical/logical, musical/rhythmic, kinesthetic, naturalist, interpersonal, and intrapersonal. Students can optimize learning when teachers identify their preferred mode of learning and consider their learning mode during instruction (Nolen, 2003). A student's learning becomes more powerful when the student understands how they learn (Sadler-Smith, 2005).

A third differentiated strategy is interest centers or interest groups. This strategy allows students to make choices and take ownership in their choice, which can also lead to a boost in their self-esteem (Bender, 2005). Interests groups satisfy curiosity, allows study of topics not in the regular curriculum, allow for study of topic in greater depth, and encourage students to make connections between fields of study or between study and life (Tomlinson, 2001).

A fourth differentiated strategy is tiered assignments. Having tiered assignments allow students to begin learning from where they are, promotes success, and avoids work that is too hard or too easy (Tomlinson, 2001).

Virtual and Concrete Manipulatives

Virtual Manipulatives

Understanding mathematical concepts is imperative if children are to grasp the higher level thinking skills (Brown, 2007). According to Brown,"virtual manipulatives are essential for thorough, teaching of mathematical concepts" (p. 10). It is also important that teachers continue to explore effective methods of teaching mathematics so all students are successful (Reimer & Moyer, 2005). Even though concrete manipulatives are believed to improve children's understanding of mathematics; however, virtual manipulatives are also a powerful instructional tool (Brown, 2007). In fact, some researchers argue the fact that virtual manipulatives are more effective in teaching mathematics than concrete manipulatives (Taylor, 2003).

According to Reimer and Moyer (2005), "virtual manipulatives are essentially replicas of physical manipulatives placed on the World Wide Web in the form of computer applets and additional advantageous features (p.6). Virtual manipulatives are a "visual representation of a dynamic object that presents opportunities for constructing mathematical knowledge" (Moyer, 2002, p. 373). The use of virtual manipulatives are more abstract and can be used to reinforce the conceptual understanding (Ozmantar, 2005).

The use of virtual manipulative in a differentiated classroom allows students to solve their own problems, work cooperatively in pairs, and reflect on their actions (Ozmantar, 2005). Virtual manipulatives can also be used as an assessment tool as mirrors of students' thinking (Ozmantar, 2005).

According to Reimer and Moyer (2005), a study conducted on fractions in a third grade class using virtual manipulatives, showed significant improvement in students' test results. The participants in the study consisted of 19 third graders. The student population included several special needs students, four autistic children, three children whose primary language was other than the English language, three children with varied learning disabilities, and four gifted and talented children. The classroom setting was one in which children worked in cooperative learning groups. Students participated in a two-week project with a focus on fractions. During the first week, the students took a pretest to assess their knowledge of fractions and computational skills. The teacher introduced virtual manipulatives to students by using base 10 blocks applet. Using the base 10 blocks applet prior to the study allowed students to familiarize themselves with the computer program. During the next week, the teacher taught fraction concepts. The introduction of the lesson began with the virtual manipulative applet. Students received teacher-made worksheets with instructions on how to use the virtual manipulative applet.

Students then worked independently on the assignments. During the activity, interviewers asked students three general questions:

1. What are you doing?
2. Can you explain how you are using the virtual manipulatives?
3. How is this helping you learn fractions?

Student interviews indicated that students liked the virtual manipulatives applet because they provided immediate feedback. Students felt that the virtual manipulatives were faster and easier to use. They also had a positive experience working with the virtual manipulatives. They thought it was a cool experience and helpful to their learning. A questionnaire completed by students yielded the same results. The results of the study statistically showed improvement in students' posttest of conceptual and procedural knowledge. The results also showed that virtual fraction manipulatives had an impact on students' learning.

Steen, Brooks, and Lyon (2006), conducted a study to investigate the impact of virtual manipulatives and attitudes of first grade students on academic achievement. The study consisted of 31 first graders. The population included 21 Caucasian, two Hispanic, one Native American, three African American, one Middle-Eastern, and three Asian students. According to a parent/guardian survey that was sent out, 74% of the students' households had home computers, and 64.5% had Internet access. Students were randomly assigned to either the treatment group or the controlled group. In the treatment group, 75% of the students had home computers and 68.8% had Internet access. The controlled group had 80% of the students with home computers and 60% had Internet access. Both groups studied the same objectives but the treatment group used virtual manipulatives for practice. A pretest and posttest at both first and second grade levels was conducted. The pretest indicated that the treatment group began at a significantly lower than the controlled group, ($p < 0.05$) on the first grade level of testing. According to the posttest results, the treatment group outscored the controlled group on both grade level tests but not at a significant level ($p > 0.05$). However, the treatment group had significant improvements ($p < 0.05$) on both grade level tests, while the control group only had significant improvements ($p < 0.05$) on the second grade level of testing. The teacher recorded her daily thoughts in regards to using the virtual manipulatives. The teacher also noted students' attitudes, behaviors, and interactions. The teacher found that students showed increased motivation and challenged themselves to higher levels.

Concrete Manipulatives

Manipulative materials are concrete models that can be touched and can be moved around by children as they learn (Lewis & Batts, 2005). The use of concrete manipulatives is essential to student success (Bovalino & Stein, 2001). According to Bovalino and Stein, concrete manipulatives are important tools in helping children think, reason, and make connections to what they are learning. Bovalino and Stein continued to state that using manipulatives in the classroom is important to the success of all children. Manipulatives offer students hands-on learning and provides a natural way for children to understand mathematics. Manipulatives also help students analyze and solve problems pictorially making understanding easier (Bovalino & Stein, 2001). Bovalino and Stein also stated, "Giving students concrete ways to compare and operate on quantities, such manipulatives as pattern blocks, tiles, and cubes can contribute to the development of well-grounded, interconnected understandings of mathematical ideas" (p. 356). Using concrete manipulatives help students to make connections that are meaningful and students tend to retain what they have learned.

In order for manipulatives to be an effective part of the lesson, teachers must invest time, prepare for lessons, and practice before presenting to students (Bovalino & Stein, 2001). Without teachers investing their time often leads to undesirable outcomes for students and teachers (Bovalino & Stein, 2001). According to Karp and Voltz (2000), "Using manipulative materials well takes reflective practice" (p. 212). Manipulatives are important in improving performance at all student levels, including developmentally delayed students to those who are gifted and talented (Karp & Voltz, 2000).

Manipulatives do not require students to reason abstractly (Bruner, 1995). The experience with such objects helps students discover abstract principles (Bruner, 1995). Bruner emphasized the use of concrete objects as a means to instructing students. Bruner suggested using different concrete objects could move children forward. However, teachers must keep students' interest and not let them lose focus of the lesson. This happens when teachers force students to work in a systematic format or when teachers become impatient and give students answers too quickly (Bruner, 1995). According to Heuser (2000), "When children are encouraged to follow their own interests while manipulating objects, they learn more than when the teacher directs each movement" (p. 289). Lack of supervision and direction as students explore with concrete objects result in an unsuccessful lesson (Bovalino & Stein, 2001).

Many teachers fail to use manipulatives in their classroom due to lack of availability, insufficient budgets for manipulatives, and lack of administrative support (Jones & Moyer, 2004). The amount of control in the classroom, the importance of the materials, and being overwhelmed with all other classroom obligations are other reasons why teachers fail to use manipulatives (Jones & Moyer, 2004). Some teachers also feel that using manipulatives take up too much of their instructional time (Jones & Moyer, 2004). According to Moyer, Bolyard, and Spikell, (2002), teachers also feel that they do not have enough concrete materials and distributing and clean up is too time consuming. Regardless, teachers need to find manageable ways so that manipulatives become part of their lessons (Moyer et al., 2002). To ensure that students benefit from a manipulative lesson, teachers must follow several guidelines:

1) Manipulative materials should be used frequently in a total mathematics program in a way consistent with the goals of the program.
2) Manipulative materials should be used in conjunction with other aids, including pictures, diagrams, textbooks, films, and similar materials.
3) Manipulative materials should be used in ways appropriate to mathematics content, and mathematics content should be adjusted to capitalize on manipulative approaches.
4) Manipulative materials should be used in conjunction with exploratory and inductive approaches.
5) The simplest possible materials should be employed.
6) Manipulative materials should be used with programs that encourage results to be recorded symbolically. (Durmas & Karakirik, 2006, p.4)

   Durmas and Karakirik (2006) continued to emphasize that using manipulative material in teaching mathematics will help students learn:

7) To relate real world situations to mathematics symbolism.

8) To work together cooperatively in solving problems.
9) To discuss mathematical ideas and concepts.
10) To verbalize their mathematics thinking
11) To make presentations in front of a large group.
12) That there are many different ways to solve problems.
13) That mathematics problems can be symbolized in many different ways.
14) That they can solve mathematics problems without just following teachers' directions (p.4).

It is important to keep in mind that students learn at different rates (Taylor, 2003). Taylor also emphasized the fact that the selection of manipulatives must be done carefully to ensure that they are developmentally appropriate and that the manipulatives provide a quality learning experience.

Each MOOTB lesson includes a kit of manipulatives needed to teach each lesson effectively. The use of manipulatives throughout the learning cycle of each lesson provides a powerful way in assessing students as they investigate mathematical ideas (Moss, 2008).

Constructivist Theories

Constructivist views on learning can be used to develop student-centered, inquiry-based approach to learning (Gardner, 2006). Constructivists' theories focused on how students learn. Each of the following theorists, Howard Gardner, Lev Vygotsky, Jean Piaget, and Jerome Bruner outlined how children learn and construct knowledge.

Howard Gardner

Being aware of how children learn at different intellectual levels, teachers hold the key to student success and have a critical role in instructing them (Schwartz, 2005). Howard Gardner's theory on multiple intelligences required teachers to adjust their instructional strategies in order to meet students' individual needs (Gardner, 2004). According to Gardner, there are eight kinds of intelligences. Gardner's first intelligence is *word smart* or *linguistic* and *verbal*. According to Gardner, verbal intelligence involved the mastery of language. Students with verbal intelligence tend to have highly developed auditory skills and think in words. Gardener emphasized that language enables them to memorize material easily. Gardner also stated that verbal students are skillful storytellers. In order for teachers to help linguistic learners, they must use language that the student can relate to and fully comprehend.

Music smart or *musical intelligence*, a second type of Gardner's intelligence, makes use of sounds. Gardner stated that students with musical intelligence have a strong understanding of pitch, rhythm, and timbre. Gardner continued to emphasize that through music, children are able to convey their emotions because music can act as a way of capturing feelings.

Logic smart or *mathematical-logical intelligence*, a third type of Gardner's intelligence, consisted of the ability to detect patterns, reason deductively, and think logically. According to Gardner, children exercise this intelligence by ordering and re-ordering objects. Gardner believed that over time, children take their knowledge of using material objects (such as marbles and M & Ms) and begin to think mathematically without the use of manipulatives. Gardner stated that these children learn best by categorizing, classifying, and working with abstract patterns and relationships. Gardner stated that these children usually do well in the traditional classroom because they are able to follow the logical sequencing behind the teaching and calculate very quickly.

Picture smart or *spatial intelligence*, a fourth type of Gardner's intelligence, grows out of the visual world. According to Gardner, spatial intelligence gives a person the ability to manipulate and create mental images in order to solve problems. Gardner stated that spatial thinkers "perceive the visual world accurately, to perform transformations and modifications upon one's initial perceptions, and to be able to re-create aspects of one's visual experience, even in the absence of relevant physical stimuli" (p. 173). Gardner also stated that children with spatial intelligence learn best by using pictures or photographs. Gardner believed that students benefit from films, overheads, diagrams, and other visuals because their learning can be effectively assessed by having them use drawings or diagrams to demonstrate their thinking and learning.

Body smart or *bodily-kinesthetic*, a fifth type of Gardner's intelligence, entails the ability to understand the world through the body. Gardner stated that children like to touch things in order to learn. Gardner believed that children learn best by moving, interacting with space, and processing knowledge through bodily sensations. According to Gardner, children enjoy keeping their hands busy; therefore, different learning tools brought to the classroom can accommodate these students. Gardner continued by saying that these students might seem fidgety during much of the class, but simply giving them something to keep in their hands might solve this problem. An individual's sense of self, "his most personal feelings and aspirations, as well as that entity to which others respond in a special way because of their uniquely human qualities" can influence the way in which a bodily-kinesthetic student learns (Gardner, 1983, p. 235).

People smart or *interpersonal intelligence*, a sixth type of Gardner's intelligence, consists of the ability to understand, distinguish, and discriminate between people's moods, feelings, motives, and intelligences. Gardner believed that children working together can foster interpersonal intelligence. According to Gardner, children with interpersonal skills like to have many friends, talk to people, and join groups. Children are good at understanding and leading others. Gardner stated that these children learn best by sharing, comparing, relating, cooperating, and interviewing. Gardner stated that interpersonal and intrapersonal intelligences share many characteristics.

Self smart or *intrapersonal*, a seventh type of Gardner's intelligence, deals with the individual self and develops from internal resources. According to Gardner, children with intrapersonal characteristics need praise frequently. Gardner stated that these children are good at understanding self, focusing inward on feelings, following instincts, pursuing interests, and goals. Gardner stated that these children learn best by working alone, by having individualized projects and self-paced instruction, and by having their own space.

The last of Gardner's intelligences is *nature smart*, *environmental* or *naturalist intelligence.* According to Gardner, each one involves the ability to understand nature's symbols. Gardner stated that these children often benefit from outdoor learning. Children like being with animals and interacting with their surroundings. Gardner continued by saying that these children are good at categorizing, preservation, and conservation. Finally, Gardner emphasized that teachers can accommodate these students by planning activities that focus on nature. Gardner stated that hands-on experiences make them feel comfortable.

All of Gardner's intelligences influence instruction and student achievement. According to Gardner, when teachers understand how children learn, it is important to design instruction that accommodates each individual learning style. Gardner concluded by saying that every learner exhibits certain intelligences, and it is part of the teachers' job to nurture and help students develop their own learning strategies (Gardner, 1983).

Lev Vygotsky

A second theory to learning is Vygotsky's sociocultural theory. Vygotsky's theory focuses on the social aspects of learning (Byrnes, 2001). According to Byrnes, Vygotsky's sociocultural theory emphasized the use of manipulatives so students have a concrete understanding of their learning. Byrnes stated that with manipulatives, students work together in a social environment and they become actively involved in the hands-on learning experiences. By using manipulatives, students learn how to solve problems and acquire a greater understanding of the lesson (Vygotsky as cited in Byrnes, 2001, p. 35).

According to Byrnes, Vygotsky also emphasized experiential learning. Byrnes stated that Vygotsky wrote extensively about learning by doing. Vygotsky's zone of proximal development receives high recognition from teachers and theorists. During this stage, the teacher serves as a guide. The zone of proximal development is "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky as cited in Byrnes, 2001, p. 36). The idea of teaching and learning allows educators to teach ahead of development, to teach for understanding, motivate students, and encourage social, personal, and academic growth (Beliavsky, 2006).

Jean Piaget

From Piaget's theory, children's thinking is concrete. The applications to Piaget's educational practice consisted of three principles.

1. First, students must internalize action schemes by performing mental computations. If a teacher wants students to perform mental computations, "students need lots of practice performing these actions overtly to reach a goal" (Piaget as cited in Byrnes, 2001, p. 20). This fits the idea of hands-on learning.
2. Secondly, when designing programs, thinking at each developmental level is considered. Teachers ask three questions when deciding whether students can understand a topic. The three questions are: (a) "How many dimensions or issues do students have to consider at once? (b) Does understanding the topic require reversible thought or an understanding of opposites? and (c) Are there things I can point to in order to illustrate the idea sufficiently?" (Piaget as cited in Byrnes, 2001, p. 20).
3. Thirdly, in order for children to move ahead in their thought processes, teachers must provide them with: (a) "precursory ideas that serve as the foundation for later ideas; (b) experiences that contradict their current, incorrect understandings; and (c) alternatives that they can grasp and execute" (Piaget as cited in Byrnes, 2001, p. 21).

According to Byrnes (2001), children must interact with the physical and social world or they will not develop the structures associated with Piaget's four stages by the time they reach physical maturity in adolescence.

Jerome Bruner

According to Cooper (2005), Bruner's theory called for the use of concrete objects. Bruner believed that children's thinking focused on concrete materials where students interacted with the environment by exploring and manipulating objects. Bruner (2004) suggested that using many different concrete objects during instruction helps children move beyond the perceptual properties of the individual object (Cooper, 2005). Bruner also believed that "learning is an active process in which learners construct new ideas or concepts based upon their current/past knowledge" (Bruner, 1960, para. 1).

Cooper (2005) also stated that Bruner outlined three stages of intellectual development. The first stage he called "Enactive." According to Cooper, during this stage, children learn about the world through their actions and the consequences for those actions. The second stage he called *Iconic*. Cooper explained that during this stage, children use models, symbols, and pictures to gain an understanding of what they are learning. The third stage he called *Symbolic*. During this stage, children begin to think abstractly. Their experiences move from the concrete to the abstract and their knowledge of new concepts moves from known to unknown (Schwartz, 2005). Bruner recommended that using concrete, pictorial, and symbolic activities in conjunction lead to positive results and effective learning (Bruner as cited in Cooper, 2005, para. 1).

The Importance of Math Out of the Box

MOOTB Defined

MOOTB is an inquiry-based mathematics program designed for grades kindergarten through fifth grade. The curriculum was completed in the spring of 2008 by a team of researchers in the Department of Mathematical Sciences, College of Engineering and Science at Clemson University. The curriculum is designed so that students construct their own knowledge under the guided instruction of the teacher (Moss, 2008). The MOOTB team also designed the curriculum with a goal of changing the way in which teachers instruct mathematics (Moss). It is a standards-based, research-based, and inquiry-based mathematical program (Moss, 2008).

The MOOTB developers have worked at all levels of education. As a result of their experiences, the developers formed the following beliefs which are supported by the National Council of Teachers of Mathematics, (NCTM, 1989).

1. All students must have access to a curriculum that connects mathematical ideas.
2. All teachers of mathematics need to be confident in their own teaching and learning as well as that of their students.
3. Students need to have rich and varied experiences and materials as part of their mathematical learning.
4. Assessment guides students in knowing what they have learned, aids teachers in planning instruction, and informs the community.
5. Technology supports students and teachers as they engage in rich mathematical experiences (Moss, 2008, p.1).

MOOTB is developed through a rigorous process of research, development, lesson testing, and revision (Moss, 2008, p. 2). The MOOTB curriculum is researched and developed by teachers under the guidance of specialists in science and mathematics reform (Moss). The lessons designed are reviewed by teachers and practitioners, representing all levels of mathematical teaching (Moss). According to Moss (2008), the lessons are field-tested and information is gathered through assessment items, teacher reflections, videos, student work samples, parent feedback, pre/post tests, and anecdotal records. The publisher's project team monitors lessons through the field-test phase. After field test in diverse classrooms, the lessons are once again reviewed and revised under the guidance of the editorial and layout team of the publisher (Moss, 2008).

MOOTB Study

A study was conducted in a New Jersey Suburban elementary school district in which MOOTB curriculum was implemented. There were 12 teachers trained by the MOOTB developers. Each teacher implemented the MOOTB curriculum and the remaining teachers used the school district's current math curriculum (Rock & Courtney, 2009). To measure achievement, an assessment developed by the Educational Testing Service (ETS) and the New Jersey's standardized math proficiency test (NJ ASK) was used (Rock & Courtney). Based on the results from the study, students who were instructed using the MOOTB curriculum performed somewhat better on the ETS than students who did not use the MOOTB curriculum (Rock & Courtney, 2009).

Differentiated Instruction

Achievement gaps continue to be a major issue in education. Even in districts that have adopted reform curricula, achievement gaps among subgroups remain (Building Engineering and Science Talent, BEST, 2004). Research supports the fact that many cultural differences contribute to achievement gaps (BEST). Some of these differences relate to curriculum that does not effectively tap students' cultural experiences (BEST). The more teachers understand the differences, the better chance they have of meeting the needs of such a diverse group of students (Brent & Felder, 2005).

This evidence suggests that the current programs are not providing sufficient instructional support to enable teachers to differentiate instruction so that all student learning needs are met (BEST, 2004). In closing achievement gaps, instructional practice must allow for prior learning experiences, diverse learning styles, and a range of learning abilities (BEST). According to BEST, lessons must be designed that help students communicate and represent their learning in a variety of ways, lead to a broader understanding of mathematical ideas along with individual accountability, and make connections to real life outside of the classroom.

MOOTB implements various differentiated strategies. Some examples of these strategies during a lesson include the use of manipulatives, which meet the needs of your bodily-kinesthetic learners who need to touch things in order to learn (Gardner, 1983). Another example of how MOOTB meet needs of learners is through cooperative learning groups. Each MOOTB lesson allows students to work together and learn from one another (Moss, 2005). Working together helps students to foster interpersonal intelligence (Gardner, 1983).

Each MOOTB lesson also includes opportunities for students to write and create visuals to demonstrate their level of learning (Moss, 2005). Information from each lesson can be gathered from class discussions, teacher observations, individual and group questioning, making connections, which may consist of a connected practice assignment, a post-assessment, which integrates skills learned in previous lessons and provide an opportunity for the students to use in new situations, sharing and reviewing strategies, and summarizing (Clemson University, 2009). These differentiated instructional elements, which are embedded in each MOOTB lesson, provide teachers with the innovative materials necessary in order to meet the needs of diverse learners (Moss, 2005).

Curriculum Design

The need for a comprehensive inquiry-based mathematical program and flexibility guided the developers of MOOTB in designing four interrelated curriculum content standards (Smith, 2005). The individual strands focus on specific content areas, which over time will provide a coherent and comprehensive mathematical program that fully meets national standards (MOOTB, 2005). Smith states that when the four content strands are fully implemented, each strand will provide a coherent and comprehensive mathematical program meeting national standards at all grade levels (MOOTB, 2005).

Material Support

MOOTB materials, manipulatives, and models provide a physical means where students can develop and demonstrate what they are learning (Van de Walle & Lovin, 2006). Each model contains a teacher's manual and kit with all the materials needed to teach the lessons effectively (MOOTB, 2005). Each kit contains enough materials for a class of 30 students. Lessons designed for hands-on experiences ensure that all students have opportunities to explore and demonstrate mathematical ideas using concrete materials (MOOTB). The instructional materials are an integral part of the learning experience (MOOTB, 2005).

Benefits of MOOTB

Learning Cycle

MOOTB offers several benefits to its users (Moss, 2008). According to Moss, MOOTB is developed around a learning cycle based on research on how children learn. The learning cycle is used to foster inquiry-based learning (Moss, 2008). The learning cycle used in the lessons gives teachers the structure needed to reach all students (Moss, 2008). The learning cycle fits Tomlinson's theory of differentiating instruction. As Tomlinson (2001) stated, "a differentiated classroom provides different avenues to acquiring content, to processing or making sense of ideas, and to developing products so that each student can learn effectively (p. 1). Within the learning cycle, students can "make connections between past and present learning experiences and is based in the "cognitive principle of assimilations," which implies that understanding cannot be imposed on the learner, but instead is developed progressively by the learner" (Moss, 2005, p. 3). The learning cycle allows students to connect learning with what they already know (Moss, 2008)).

Moss (2008) continued to explain the phases of the learning cycle. There are four phases included in the learning cycle: engage, investigate, reflect, and apply. In the engaging phase, students bring a natural curiosity about their world to the classroom. Posing questions, brainstorming ideas, and discussing solutions help engage students and lay the groundwork that leads to further investigation. This phase also allows students with a variety of prior experiences to make connections between what they have already learned to what they are going to learn. These connections provide a pre-assessment opportunity for the teacher and the student (Moss, 2008).

The investigation phase includes research, experimentation, observations, building models, and redefining questions (Moss, 2008). According to Moss, students are given concrete experiences that challenge them to solve problems. Information is gathered, patterns observed and analyzed, connections made, and conclusions defended. Students are also engaged in mathematical reasoning (Moss, 2008). Howard Gardner's (2004) theory of multiple intelligences would fit well in the investigation phase because students are engaged and can demonstrate their own knowledge according to how they learn. Vygotsky's theory, which is based on social aspects of learning, is a benefit of this phase because students are working together and developing concepts by using concrete objects to construct meaning (Brynes, 2001).

The reflection phase is where students think about what they have learned and how they learned it (Moss, 2008). They compare their findings with findings of others. According to Moss, students think about what they have discovered, built or experienced, and how it was relevant to their learning. Students communicated their findings in a variety of ways. Moss continued to state that the role of the teacher is especially crucial during this phase because it is where the knowledge of the teacher is important in assisting students in summarizing and structuring their thinking into meaningful knowledge for further investigation. Students take ownership of new knowledge during this phase (Moss, 2008).

The final phase, application, is where it all comes together. Students make connections to past learning, new knowledge, and real-world experiences (Moss, 2008). Students begin to see patterns and connections to their knowledge of the world. The new knowledge becomes old on which to connect new learning (Moss, 2008). Students are more likely to retain their ideas and concepts because they can see the connections. According to Moss (2008), the teacher and students can pose new situations and problems to ensure a deeper understanding. The cycle of learning connects mathematical concepts throughout each lesson and is crucial to mathematical success (Moss, 2008).

In addition to the learning cycle, MOOTB is designed around several components essential to inquiry. These components include the following:

- development of a community of learners
- a model for verbal and written communication
- explicit connections that make mathematics meaningful
- balanced assessment practices
- a diversity of materials, manipulatives, and models (Moss, 2008, p.4).

Development of Community Learners

Teachers and students offer varied perspectives based on prior experiences and opportunities (Clemson University, 2009). Clemson University researchers stated that as students work together, connections are made based on past and present learning experiences. Learning is developed by the learner beginning with concrete and progressing to abstract (Clemson University, 2009). According to Moss (2008),

> Extensive research corroborates the effectiveness of collaborative groups in K-5 classrooms and their use to build a learning community. After examining the large body of research on cooperative groups, one group of researchers conclude that "Markedly different theoretical perspectives (social interdependence, cognitive-developmental, and behavioral learning) provide a clear rationale as to

why cooperative efforts are essential for maximizing learning and ensuring healthy cognitive and social development as well as many other instructional outcomes". (p. 4)

Model for Verbal and Written Communication

The communication model in MOOTB lessons provides verbal and written experiences throughout each sub-concept (Moss, 2008). Discussion, questioning, reflection, and writing are communication strategies that ensure connections are meaningful and thinking occurs throughout the lessons (Moss, 2008). "Communication in the mathematics classroom permits learning to build on the students' informal knowledge, gives students practice in explaining their mathematical thinking to others, and provides students and teachers with evidence that learning has occurred" (Moss, 2008, p. 4).

The communication model also builds a community that allows students to take risks so that written and verbal communication can occur and develop (Clemson University, 2009). Throughout the lessons, communication evolves and improves as the communication and the writing moves from part of the community to individual accountability (Clemson University, 2009). Within the communication model, formative assessment is continuous instead of at the end of lesson or unit (Clemson University, 2009).

Explicit Connections that make mathematics meaningful

Students and teachers bring a variety of experiences to the classroom (Clemson University, 2009). According to Clemson University researchers, students have mathematical ideas that you may not have taught them. Recognizing the diversity in students thinking contributes to the learning of all (Clemson University, 2009).

MOOTB curriculum is designed in which students will develop the ability of making mathematical connections meaningful (Moss, 2008). “The ability to recognize relationships among mathematical ideas and to apply those ideas beyond the mathematics classroom has long been recognized as a hallmark of mathematical understanding” (Moss, p.4). The benefit of mathematical connections in developing a sound understanding is an essential part of learning mathematics (Moss, 2008).

Balanced Assessment Practices

Planning for balanced assessments is important when helping children to succeed. “Teachers who develop useful assessments, provide corrective instruction, and give students second chances to demonstrate success can improve their instruction and help students learn” (Guskey, 2003, p. 7). It is important that teachers develop and administer useful assessments that demonstrate success in the classroom. Guskey stated, “The assessments best suited to guide improvements in student learning are the quizzes, tests, writing assignments, and other assessments that teachers administer on a regular basis in their classrooms” (p. 7). Guskey continued to explain that students spend numerous hours preparing for assessments and then discover that the material studied was different from what the teacher emphasized. According to Guskey, this experience teaches students two unfortunate lessons: (a) students realize that all of their hard work and efforts failed because the test results did not show evidence of studying, and (b) students learn to have little trust in their teachers. As Guskey stated, these are not the messages we want to send to students.

MOOTB is not designed to send these messages but is designed to improve student achievement for all students. MOOTB assessments are built around the concepts and skills learned from each unit and are part of the lesson instead of an interruption (Clemson University, 2009).

The goals of MOOTB are as follows:

- to guide students in knowing what they have learned
- to allow the teacher to understand how students are thinking about mathematics
- to aid teachers in planning instruction
- to inform the community (Moss, 2008, p.5).

There are two types of assessments used throughout the MOOTB teaching module, which are formative and summative assessments. Formative assessments are embedded into the lessons and provide information to the teacher for instructional decisions (Moss, 2008). Brainstorming is one type of formative assessment that takes place in the engage phase of each MOOTB lesson. Brainstorming is used as a pre-assessment in which the teacher asks questions in an effort to substantiate prior knowledge and determine any misunderstandings that need to be addressed (Clemson University, 2009). During the investigation phase, the teacher is continuing to question students to determine their level of understanding. This questioning can be directed to individual students or to the whole group (Moss, 2008).

Another example of formative assessment in a MOOTB lesson is in student writings, which are also a way for students to communicate (Clemson University, 2009). Information obtained from students writing shows the students understanding of concepts and skills, students' ability to put thoughts on paper, and students' attitudes about mathematics (Clemson University, 2009). Each lesson provides an opportunity for students to explain their thinking verbally and in writing. The teacher can also assess students learning as they work together and share ideas.

Each MOOTB lesson also includes a reflective and connected practice. The reflective practice provides an opportunity for students to solve a variety of problems and think about their own learning and is used during the investigation phase of each MOOTB lesson (Clemson University, 2009). The connected practice connects subconcepts, facts, and procedures to other curriculum areas and to everyday life and is used in the application phase of each MOOTB lesson (Clemson University, 2009). Based on the needs of the students, the connected practice activity can also be used with the whole groups, small groups, or individually (Clemson University, 2009).

A home connection activity is another formative assessment used in MOOTB. The home connection practice makes a connection between classroom learning and the home and allows students to apply their skills in a new situation, while informing their family to what is being taught in the classroom (Clemson University, 2009). This is given as a homework assignment for students.

A checklist is also used as a formative assessment in which the teacher makes general and specific observations (Clemson University, 2009). General observations are made when the teacher is circling the room while students are working individually or working in small groups and recording notes. The purpose of making general observations is to collect data over time in order to analyze patterns and trends (Clemson University, 2009). When making specific observations, the teacher observes, questions, and comments with a specific purpose in mind and focuses on specific students or groups of students (Clemson University, 2009). From these formative assessments, the teacher can determine misconceptions students may have areas of weaknesses and strengths, and gaps that exist (Clemson University, 2009).

Summative assessments provide additional information about student learning and can be evaluative in nature. Included in the lesson are also a variety of ways in which students can demonstrate their knowledge and skills (Moss, 2008). In MOOTB, a post-assessment is included at the end of each subconcept as a summative assessment. An assessment rubric is also used to indicate mastery and areas needing improvement. The post-assessement is given at the end of each subconcept.

Diversity of Materials, Manipulatives, and Models

"Researchers advocate an environment of hands-on experiences in mathematics classrooms" (Moss, 2008, p.6). Within in the MOOTB kit are manipulatives, charts, graphs, writing models, and diagrams needed to teach the lessons effectively (Moss, 2008). Each unit also includes a teacher's manual with student blackline masters. The materials are part of the curriculum. Professional development workshops are provided to ensure that teachers are using the materials effectively (Moss, 2008).

Using the materials throughout the learning cycle of each lesson provides a powerful means of formative assessment for teachers as students mathematically investigate (Moss, 2008).

Case Study in MOOTB

A study was conducted in a second, third, and fourth grade classroom of a public elementary school located in South Carolina. The study examined the question: How do teachers change their instructional practice when implementing an inquiry-based mathematical curriculum (Linder & Gunderson, 2009)? Nineteen teachers participated in the implementation process. There were seven teachers at the second grade level, six at the third grade level, and six at the fourth grade level. The participant's educational levels included bachelors and master's degree. The experience level ranged from one year to 20 years in an elementary setting. The elementary school involved in the study is one of forty-nine schools in the district (Linder & Gunderson, 2009). The school has an unsatisfactory rating on the statewide report card and has failed to meet all the objectives outlined by the state for AYP (Linder & Gunderson, 2009). The school received a grant to implement MOOTB with the purpose of making an impact on instruction and student achievement in mathematics (Linder & Gunderson, 2009). Teachers chosen had to be willing to implement the MOOTB program. Each teacher was observed at least 3 times over the course of three months. Teachers were asked to complete a questionnaire and participate in a focus group examining their planning practices before instruction (Linder & Gunderson, 2009).

Based on the results, evidence was clear that most teachers using MOOTB showed evidence of inquiry-based instruction on various levels and the majority of the teachers showed a complete change in instruction from traditional to inquiry (Linder & Gunderson, 2009). Participants found that the MOOTB program helped teachers who were not sure how to instruct using an inquiry-based program (Linder & Gunderson, 2009).

Another study using MOOTB was conducted using five elementary schools in a New Jersey Suburban elementary school district during the 2006-2007 school year.

There were 767 students in grades third, fourth, and fifth who participated in the study (Rock & Courtney, 2009). According to Rock and Courtney, all fifty-two teachers from third, fourth, and fifth grade participated in the study as well. There were 12 teachers trained by the MOOTB developers. The twelve teachers implemented the MOOTB curriculum during the 2006-2007 school year as a supplemental to the district's math curriculum (Rock & Courtney, 2009). The teachers received the MOOTB kits needed to implement the program. The remaining 40 teachers taught math using the school district's current math curriculum (Rock & Courtney, 2009).

The effect of MOOTB was defined as the average difference between MOOTB group and non-MOOTB group (Rock & Courtney, 2009). To measure achievement, an assessment developed by Educational Testing Service (ETS) and the New Jersey's standardized math proficiency test (NJ ASK) was used. The pre and post ETS assessments for each grade consisted of 18 multiple-choice questions and three constructed-response questions (Rock & Courtney, 2009). The highest possible score for third grade was 25, and for fourth and fifth grade were 27. The highest constructed-response score for third grade was 7 and 9 for fourth and fifth grade (Rock & Courtney, 2009).

According to Rock and Courtney (2009), results from the study showed that students who used MOOTB did somewhat better on the ETS than students who did not use MOOTB. Even though the results were small, the differences between the groups were statistically significant.

Student Achievement

Factors that Affect Student Achievement

Differentiated instruction, learning styles, and classroom environment are sources that contribute to achievement differences in children. According to Tomlinson (2001), four principals of a differentiated classroom are as follows:

- Start with good curriculum.
- Assessments must be on-going.
- All students participate in “respectful work.”
- Must have flexible grouping.

These four principals are also rooted in the MOOTB curriculum. Each phase of the learning cycle provides opportunities for students to share ideas, connect what they have learned with what they know, use concrete experiences, and structure their thinking into meaningful models of mathematical ideas they have explored (Clemson University, 2009). Assessments are also continuous throughout the phases, and students are working in flexible groupings (Clemson University, 2009).

The classroom environment is an important part of student achievement. Fish, O’Connor, and Yasik (2004) emphasized that the major goal of research is to examine all areas within the classroom setting that have an impact on student learning. According to Burke and Samide (2004), how teachers structure their classrooms has an impact on a child’s success and failure. Burke and Samide also emphasized that teachers need to understand the importance for redesigning their classrooms correctly. This provides all students with the “necessary space to accommodate their environmental learning style preference” (p. 239). Burke and Samide agreed that altering the classroom gives the students the opportunity to work in formal areas, which may include working at your desk, sitting in a chair, or working at a table. The other students can choose informal areas such as couches, rugs, and other areas where students feel comfortable. Students who work cooperatively in the classroom are less worried about failure because their focus is on how they can accomplish a task. Children see their mistakes as an opportunity for improvement (Burke & Samide, 2004).

Using an inquiry-based approach (MOOTB), students have autonomy within defined parameters to discover, explore, and create multiple options in reaching a solution (Linder & Gunderson, 2009). The classroom environment is one where students can explore by working at tables, sitting on the floor, arranging desks in groups of four, or working alone in an area of your choice (Clemson University, 2009).

Valeski and Stipek (2001) noted that when students have a positive attitude, it is reflected in their academic performance. Schunk (2003) pointed out that highly efficacious students staying on task keep the classroom climate orderly and functioning. However, students that have low self-efficacy will often disrupt the environment. Sinclair and Fraser (2002) found that providing teachers with information about students' perceptions improved the classroom environment.

In using MOOTB, students work in groups as they explore mathematical concepts together. This reduces the fear of failure and encourages discussion among students (Clemson University, 2009). Therefore, students are engaged, and the classroom climate is one that is focused which keeps students on task.

Classroom learning requires social interaction, but there must be a balance between levels of interaction and distraction. According to Marzano (2003), effective classroom management must include established rules and procedures with defined expectations for behavior and activities. Teachers and students must work together in order to accomplish a common goal; the teacher leads and the students learn. Teachers are responsible for instructing, delivering, and supporting all students (Marzano, 2003).

In using MOOTB, social interactions are a blend of student-to-student, student to teacher, and teacher to student (Linder & Gunderson, 2009). Students and their peers recognize themselves as sources of mathematical information (Linder & Gunderson, 2009). According to Linder and Gunderson, when working in groups, the teacher values that learning. Linder and Gunderson also stated that students have confidence in their ability to produce quality work, and the teacher gains confidence in the students' ability to assess the quality and accuracy of their peers' work.

According to Linnenbrink and Pintrich (2003), motivation is a factor that influences student achievement. Linnenbrink and Pintrich focused on intrinsic motivation as an academic enabler that influences student achievement. Intrinsic motivation is an individual's engagement in an activity. Personal and situational interests relate directly to intrinsic motivation. Personal interest is a stable construct, whereas situational interest varies according to the learning situation. Making the content meaningful and allowing students to choose their own topics for particular assignments enhance both personal and situational interests.

MOOTB provides individual activities in which students apply what they have learned (Clemson University, 2009). The teacher and the student can assess their level of understanding and pursue individual interests. This encourages each student to be accountable for his or her own learning (Clemson University, 2009).

Summary

Differentiating instruction and using an inquiry-based approach (MOOTB) to teaching mathematics is essential to learning. The literature review addressed several areas concerning differentiated instruction. The literature review also addressed the importance of using MOOTB, benefits of MOOTB, learning theorists, and factors that affect student achievement.

Teachers are critical to students' opportunities to learn and to learn mathematics (Moss, 2008). The MOOTB team designed the curriculum so that teachers change their instructional practice and mathematical content knowledge. It is important for teachers to understand how each individual learns. Recognizing differences and analyzing teaching methods provide a rich learning environment. Implementing MOOTB is a move away from the traditional style of teaching to an inquiry-based approach to teaching mathematics.

Section 3: Methodology

Introduction

Differentiated instruction, learning styles, and classroom environment enhance student learning. The literature review indicated that every child is unique and capable of learning and teachers must accommodate for these differences. It is important to structure the learning environment and develop a foundation on which students become lifelong learners.

This quantitative method research study attempted to test the effects of teaching math through a differentiated approach using Math Out of the Box (MOOTB) versus a traditional approach using the textbook on math achievement of fifth grade students at an urban elementary school located in a southern state. This study also attempted to determine whether there is a significant difference between MOOTB and fifth grade students' attitude toward math and traditional fifth grade students' attitude toward math relative to confidence, value, enjoyment, and motivation. The study covered a period of approximately 9 weeks. During this time, participants took a computerized Measures of Academic Progress (MAP) pretest during their regular math block. This test occurred during the fall MAP testing schedule. Participants also took a MAP posttest during their regular math block. This posttest occurred during the winter MAP testing schedule.

The quantitative design in this research study was the quasi-experimental, nonequivalent control-group design because both groups took a pretest and posttest during the fall and winter MAP testing schedule. A non-probability sample or convenience sample was also appropriate for this quantitative method study because the four classes were already intact and chosen based on their convenience and availability (Creswell, 2003).

This quantitative study includes an analysis of the results based on students' MAP score results from using differentiated instruction via MOOTB versus traditional textbook in the areas of race, gender, and socioeconomic status on math achievement. The quantitative section also includes an attitude survey sent home with all students (see Appendix A). The researcher measured the differences in scores using the one-way analysis of covariance for the MAP score results. The univariate analysis of variance test was used to compare the differences between MOOTB fifth grade students' attitude toward math and traditional fifth grade students' attitude toward math relative to confidence, value, enjoyment, and motivation.

MOOTB Defined

MOOTB is a standards based mathematical curriculum designed for grades kindergarten through fifth grade (Moss, 2008). MOOTB was developed by a team of researchers in the Department of Mathematical Sciences, College of Engineering and Science located at Clemson University. The curriculum is one in which students construct their own knowledge under the guided instruction of the teacher (Clemson University, 2009).

Research Design and Approach

This quantitative study examined the effect of differentiated instruction strategies using MOOTB versus traditional textbook instruction strategies in math on fifth grade students. The quantitative design was the quasi-experimental, non-equivalent, pretest/posttest in an effort to evaluate whether there were significant differences in the math achievement and attitude towards math based on differentiated instruction strategies using MOOTB versus traditional textbook. A quasi-experimental design was appropriate because all four groups involved were randomly assigned. The four groups were already intact; however, there was manipulation of the independent variable by randomly assigning two groups to differentiated instruction via MOOTB.

The research study took effect at the school where the researcher works during the fall of 2010, beginning in November and covered a period of approximately 9 weeks. During the nine weeks of study, students in Groups A and B received differentiated instruction via MOOTB, while students in Groups C and D received direct instruction from the researcher using the traditional textbook.

For this quantitative study, participants were taken to the computer lab for the MAP pretest and posttest. Results from the MAP pretest and posttest were printed and analyzed using the Statistical Package for the Social Sciences (SPSS) program. The ANCOVA was the statistical test used to measure these results. Once pretest and posttest results were collected, an attitude survey was sent home with the students.

Dr. Martha Tapia, associate professor at Berry College, developed the survey instrument that was used in this research study to determine attitudes of students toward math. All students were given a survey to take home. The students who had been given permission by their parents, completed the survey at home and returned survey to the research assistant at the school. The research assistant placed all surveys in a folder and turned them over to the researcher. The univariate analysis of variance test was used to compare the differences between MOOTB fifth grade students' attitude toward math and traditional fifth grade students' attitude toward math relative to confidence, value, enjoyment, and motivation.

The researcher completed an application to conduct research established by the district (see Appendix B). The district research committee consisted of a chair and two other members from the district. The selected staff members were knowledgeable in the proposed subject. Each committee member reviewed the research proposal and submitted comments and recommendations to the Director of Research, Evaluation, and Accountability. The researcher discussed the study with the administrative team at the school where the study was conducted. Upon receiving approval from the district, the researcher e-mailed the building principal and the assistant principal informing them that approval was granted to conduct study from the research committee. After receiving approval from building administrators, the researcher sent home with students a letter to parents explaining the purpose of the study and a parent consent form. In the letter, the researcher explained to parents that their child's identity would remain anonymous and their child would not be penalized for not participating (see Appendixes C and D). Students were also given an assent form explaining the purpose of the study and what they would be required to do if wishing to participate (See Appendix E). Students were given two weeks to return completed survey. The research assistant collected surveys and placed them in a folder. After two weeks, the research assistant gave all returned surveys to the researcher.

Setting and Sample

Setting

This study examined multiple factors that affect math achievement and the impact these factors have on student performance in math through a differentiated approach using MOOTB versus a traditional textbook approach. The southern state school district consists of a population of 48 elementary schools in which five of those schools are Title I schools. The study took place at one Title I elementary school. The Title I school is a magnet school serving students in grades 4K through fifth grade and has a population that is rich in ethnic diversity. Of the 613 students that attend the school, African Americans represent 58% of the student body, Hispanics 22%, Caucasians 17%, and other ethnicities 3%.

Sample

There were 95 fifth grade students. The sample size for the collection of the MAP data consisted of 68 students and was drawn from the school where the researcher works. The sample size represents approximately three fourths of the population. According to Hinkle, Wiersma, and Jurs (2003), the larger the sample size, the standard error decreases. Larger sample size results in a more powerful test of the null hypothesis (Hinkle, et. al.). The alpha level in most research studies is usually set at .05 or .01 (Creswell, 2007). The .05 level was used in this research study.

The fifth grade students selected in this sample reside in a rural community located in a southern state and attend the school in which the researcher collected data. The students primarily come from a low socioeconomic status. However, some students are from middle class families. Student attendance is exceptionally high. Parents are required to attend at least one parent conference. Afterschool programs are provided for students in an effort to help those who have a lack of parental support and lack of knowledge in subject areas. Therefore, many parents find it difficult in helping their child at home with homework. The academic level of the group of students are average and above with a few exceptions.

The researcher used convenience sampling because students were not randomly assigned to groups. Creswell (2009) referred this type of sampling as convenience sampling because participants are chosen based on their convenience and availability. The sampling was also a cluster sample because the four classes selected to participate were already intact. Two homeroom classes participated in the control group, traditional textbook, and two homeroom classes participated in the experimental group, differentiated strategies via MOOTB.

Students began the day in their first period class, which was also their homeroom. There were five homeroom classes and at the end of each period, each homeroom class rotated to a different teacher and subject area. Students' homerooms stayed intact, meaning that the students traveled with their original homeroom to a different teacher. The researcher taught math, one teacher taught science, one teacher taught social studies, and two teachers taught language arts. Each time block was 50 minutes with the exception of the language arts block, which ran for 100 minutes. There were 5 minutes allotted between class rotation and time for students to settle into their next class.

Limitations and Biases

Limitations

The following includes the limitations of the study:

1. Implementing MOOTB and not following the storyline or applying strategies will skew the results.

2. The accuracy of the results in student responses concerning whether they enjoyed the differentiated instruction via MOOTB versus the traditional textbook instruction is contingent upon the information supplied by the respondents.
3. The study was limited to only fifth grade students enrolled in one urban school in a Southern state.

Biases

Researcher bias falls in the area of ethics, therefore the researcher employed the use of reflexivity. Reflexivity encourages researchers to develop the skills to respond appropriately. In the actual conduct of research, the reflexive researcher will be better placed to be aware of ethically important moments as they arise and will have a basis for responding in a way that is likely to be ethically appropriate, even with unforeseen situations (Guilleman & Gillam, 2003, p. 277). Creswell (2003) defines reflexivity as the "introspection and acknowledgment of biases, values, and interests" (p. 182) potentially held by the researcher during qualitative research. Goodall (2000) further describes reflexivity as "the process of personally and academically reflecting on lived experiences in ways that reveal deep connections between the writer and his or her subject" (p. 137).

Being the researcher and the classroom teacher, it was important to be honest when conducting research. The researcher provided a brief narrative about the researcher's leadership roles and experiences (See Appendix E).

Restatement of the Problem

The purpose of this study was to determine whether differentiated instruction via MOOTB have a significant effect on math achievement. A second purpose was to determine if there was a significant difference between MOOTB fifth grade students' attitude toward math and traditional fifth grade students' attitude toward math relative to confidence, value, enjoyment, and motivation.

Restatement of the Null and Alternative Hypotheses

Ho1: There is no significant difference in math achievement as measured by MAP test scores of fifth grade students taught using MOOTB and fifth grade students using traditional textbooks.

Ha: There is a significant difference in math achievement as measured by MAP test scores of fifth grade students taught using MOOTB and fifth grade students using traditional textbooks.

Ho2: There is no significant difference in math achievement as measured by MAP test scores between fifth grade students taught using MOOTB and fifth grade students using traditional textbooks based on race.

Ha: There is a significant difference in math achievement as measured by MAP test scores between fifth grade students taught using MOOTB and fifth grade students using traditional textbooks based on race.

Ho3: There is no significant difference in math achievement as measured by MAP test scores between fifth grade students taught using MOOTB and fifth grade students using traditional textbooks based on gender.

Ha: There is a significant difference in math achievement as measured by MAP test scores between fifth grade students taught using MOOTB and fifth grade students using traditional textbooks based on gender.

Ho4: There is no significant difference in math achievement as measured by MAP test scores between fifth grade students taught using MOOTB and fifth grade students using traditional textbooks based on socioeconomic status.

Ha: There is a significant difference in math achievement as measured by MAP test scores between fifth grade students taught using MOOTB and fifth grade students using traditional textbooks based on socioeconomic status.

Ho5: There is no significant difference between MOOTB and fifth grade students' attitude toward math and traditional fifth grade students' attitude toward math relative to confidence, value, enjoyment, and motivation.

Ha: There is a significant difference between MOOTB and fifth grade students' attitude toward math and traditional fifth grade students' attitude toward math relative to confidence, value, enjoyment, and motivation.

Treatment of Data

This study used two different statistical tests to evaluate the data that was collected during the 2010 fall semester. The null hypotheses were tested using the following statistical tests: one-way analysis of covariance (one-way ANCOVA) and the univariate analysis of variance. Treatment was gathered concurrently. The one-way ANCOVA was used for Hypotheses 1, 2, 3, and 4. The one-way ANCOVA allowed the researcher to statistically control for any preexisting differences between groups by using an additional variable called the covariant (Pallant, 2001, p. 234). The ANCOVA was the appropriate statistical test to use for this research study because the groups used in the study were already be intact, and were randomly assigned to MOOTB or traditional textbook instruction. Therefore, the researcher could partially adjust for the preexisting differences among the groups.

The univariate analysis of variance was used for Hypothesis 5. This statistical test was appropriate for this hypothesis because it showed if there was a difference between MOOTB fifth grade students' attitude toward math and traditional fifth grade students' attitude toward math relative to confidence, value, motivation, and enjoyment as measured by attitude survey instrument. Data was made available upon request.

Data Collection and Analysis

The researcher utilized two forms of data collection, which included MAP pretest and posttest and an attitude survey. The MAP pretest was administered during the fall semester to the four homerooms that were part of the study. The MAP posttest was administered during the winter semester to the same four homerooms that were part of the study. The pretest and posttest was administered in the computer lab. The MAP pretest and posttest was used to compare the achievement scores of students using MOOTB and students using traditional textbook.

Differentiated instruction is critical to student success (Tomlinson, 2001). It is defined as helping children achieve to the best of their ability by tailoring instruction at their level and providing them with different avenues to learning (Tomlinson). At the beginning of the study, the researcher began using MOOTB, numbers and operations component with two homeroom classes. Although there are four components, this was the only component the researcher used. The unit included 18 lessons, and each lesson consisted of a learning cycle. Within each learning cycle are four phases: engage, investigate, reflect, and application. The researcher began each lesson by asking questions to get students interested and lay the groundwork that lead to further investigation. All questions were asked in a way in which every student could offer an answer based on the experiences they have encountered.

Students then moved to the investigation phase in which they worked in groups, individually, or with a partner. During this phase, students were given concrete experiences that challenged them to solve problems. This phase kept students attention and focus because each student could participate without fear of failure. Students learned how to work together and help one another. The researcher visited each student, groups, or partners and asked questions about their learning. The reflection phase helped students compare their findings with others by talking about it, showing demonstrations, using computers, and writing about what they had learned. In the final phase, application, students had an opportunity to talk about how their learning connected to real-world experiences. They also talked about any patterns and connections to future learning.

When working with traditional instruction, the researcher taught each lesson using the traditional math textbook beginning in November. Each student used the same math textbook. Each lesson was introduced with an essential question and the objective for the day explained. Students recorded the essential question in their math notebook. The researcher taught each lesson by providing examples to the whole class. All students worked the same problems for practice and were given the same amount of time to complete the problem. The practice problems may or may not have been the level of each student. The main purpose of the lesson was finding the correct answer. At the end of each lesson, students were required to answer the essential question in writing. All students received the same homework assignments.

As mentioned previously, during the fall and winter semester, students were administered a MAP pretest and posttest. The statistical test that was used to measure the data was the ANCOVA. The ANCOVA is an extension of ANOVA and uses one independent variable, differentiated instruction via MOOTB, with two or more categories and one continuous dependent variable, math achievement (Pallant, 2001). The ANCOVA was used for Hypotheses 1, 2, 3, and 4 to measure the differences in MAP pretest and posttest mean scores. The ANCOVA was also used to compare the adjusted posttest means, adjusted based on pretest scores as a covariate, across the categories.

After the collection of pretest and posttest results, students took home a survey instrument. With approval from parents, students completed survey at home and then returned completed survey to the research assistant at the school. The research assistant made sure that students' names are not written on surveys. If any names were written on surveys, the research assistant asked the students to white out their name before turning in survey. All returned surveys were placed in a folder and then turned over to the researcher, by the research assistant. The statistical test, univariate analysis of variance, was used to show if there was a significant difference between MOOTB fifth grade students' attitude toward math and traditional fifth grade students' attitude toward math relative to confidence, value, motivation, and enjoyment based on survey results.

Results from the study were reported to the school district, the participating school administrative team that includes the principal and assistant principal, leadership team, teachers, parents of students involved in the study, and students involved in the study. The researcher prepared a power point presentation to present at a faculty meeting that included all teachers, the administrative team, and the leadership team which includes the instructional coach, math coach, reading specialist, Title I facilitator, magnet coordinator, and the guidance counselor informing them on the results of the research study. The researcher also prepared a visual for students that would be easy for them to understand as the researcher explained to them the results of the research study. This took take place during the first 10 minutes of one class period. Parents received a copy of the same visual presented to students with an explanation of the study results.

Reliability

The benefit of the report from NWEA on MAP data is that it aligns student progress with item difficulties on the same scale (NWEA, 2009). The scales are divided into bands called Rasch Unit (RITs). The RIT scale can be compared to a meterstick. On a meterstick, measurements are of equal value and can be used to measure physical growth over time (NWEA). The RIT scale results are reliable because they measure student achievement over time (NWEA). NWEA places all test items in RIT ranges according to difficulty. As the RIT ranges increase, so do the test items (NWEA). When students take the MAP, the system collects enough data that determines the level at which the student is able to perform and then establishes a RIT score (NWEA). This score is used to help teachers differentiate instruction and plan lessons around students' strengths and weaknesses (NWEA). Using MAP tests for this research project provided the researcher with student achievement scores in a timely manner, provided individual summary data on student achievement and summary growth, and provided a reliable and valid benchmark for students, which indicates readiness.

Dr. Martha Tapia (2004) developed the Attitudes Toward Mathematics Inventory (ATMI), which is the survey instrument used for this study. The original survey consisted of 49 items. The forty-nine items on the survey instrument were administered to 545 high school students, 302 boys and 243 girls enrolled in a mathematics class. The subjects in the study included 135 freshmen, 153 sophomores, 168 juniors, 84 seniors, and 5 eighth graders. Cronbach alpha was calculated to estimate the consistency of the scores. Four months later, the forty-nine items on the survey instrument were given again to 64 students who had previously taken the survey. Results of the forty-nine items on the survey showed that 40 of the items had an item-to-total correlation above .50 with the highest being .82. These results meant that most of the items contributed to the total inventory. The alpha value was .96. This indicated a high level of internal consistency. To increase the alpha value, the nine items that had correlations lower than .50 were deleted one at a time, which resulted in an alpha value of .97 for the forty items.

The Pearson correlation coefficient was used for test-retest reliability. The test-retest coefficient for the total scale was .89. The subscale coefficients were Self-confidence .88, Value .70, Enjoyment .84, and Motivation .78. The data showed that the subscale scores were stable over time. To estimate the reliability and internal consistency of subscale scores, Cronbach alpha was calculated for each factor.

Factor I, self-confidence, consists of 15 items which includes survey items 9-22 and 40. These items had a mean of 51.10 and a Standard Deviation (SD) of 13.13. These factor items were derived from those generated for the anxiety and confidence categories. The scores for these items had a Cronbach alpha of .95. Factor II, value of mathematics, consists of 10 items which includes survey items 1, 2, 4, 5, 6, 7, 8, 35, 36, and 39. These items had a mean of 38.37 and a SD of 6.74. These factor items produced a Cronbach alpha of .89. Factor III, enjoyment of mathematics, consists of 10 items which includes survey items 3, 24, 25, 26, 27, 29, 30, 31, 37, and 38. These items had a mean of 31.91 and a SD of 8.06. The scores on the items produced a Cronbach alpha of .89. Factor IV, the motivation factor, consist of 5 survey items which includes items 23, 28, 32, 33, and 34. These items had a mean of 15.99 and a SD of 4.95. These items, when scored and summed, produced a Cronbach alpha of .88. A high level of reliability is evident from the scores on the subscales.

Validity

When making decisions concerning student's progress, one must be confident that the test instrument is valid (NWEA, 2009). In considering the MAP test, the Northwest Evaluation Association (NWEA) uses a measurement scale that has been proven valid over time. The scale is based on the same test theory that informs the SAT, Graduate Records Exam, and The Law School Admissions Test (NWEA, 2009).

There are more than over 2,500 school districts using MAP tests to help students learn. These assessments adapt to students learning, measuring what the child knows and what the child needs to learn (NWEA). NWEA repackages current test versions four times a year. NWEA annually audits state standards to determine whether new test versions are needed. The state determines how often new tests versions are necessary. This southern school district updates testing packages every testing season because the updated version reflects the most recent adopted state standards. Reusing outdated test practices affects the validity of student scores (NWEA, 2009).

The ATMI factor structure provides evidence of content validity and covers the domain of mathematic attitudes in the areas of confidence, value, enjoyment, and motivation (Tapia, 2004). According to Tapia, the attitude variables established the content validity by relating the items to the variables. The ATMI, a 40 item inventory, uses a 5 point Likert scale with responses in the format of strongly agree, agree, neutral, disagree, and strongly disagree. The alpha coefficient is .97, a mean of 137.36, a standard deviation of 23.93, and a standard error of measurement of 5.28. All 40 of the items on the inventory had item-to-total correlations above .50 with .82 being the highest, which suggests that all the items contributed significantly.

For this quantitative research study, data was gathered from MAP pretest and posttest and survey responses. MAP data was used to compare the adjusted posttest means, adjusted based on pretest scores as a covariant. The survey data was used to determine the relationship between math achievement and attitudes towards math.

Confidentiality of Participants' Rights

The researcher at the school where the study implementation took place will obtain MAP pretest and posttest results. The information available to the researcher was the pretest and posttest RIT scores, RIT gains, gender, free or reduced meals coding, and ethnicity. This is the same information that is provided to the school district for evaluating how well the school is performing in meeting accountability standards. The participants in this study were only fifth grade students. All data collected are stored on the researcher's computer. The survey data is kept in a secure place. The researcher made copies available to the district where the researcher is employed upon request.

Summary

The purpose of this quantitative study was to compare differentiated instruction via MOOTB to traditional textbook instruction on math achievement. This study attempted to determine if there was a significant difference between MOOTB and fifth grade students' attitude toward math and traditional fifth grade students' attitude toward math relative to confidence, value, enjoyment, and motivation. MAP data were used to measure student achievement in the areas of race, gender, and socioeconomic status. SPSS 19.0 was the statistical program used to analyze the data. Significance was measured using one-way ANCOVA. The univariate analysis of variance for the survey data was used to compare the differences between MOOTB fifth grade students' attitudes toward math and traditional fifth grade students' attitudes toward math relative to confidence, value, enjoyment, and motivation. Section 4 includes an analysis of the data followed by a summary of the findings, conclusions, recommendations, implications for social change, and suggestions for future research in section 5.

Section 4: Analysis of Data

Introduction

This doctoral study examined whether differentiated instruction using MOOTB had an impact on student achievement compared to traditional textbook instruction. In addition, this study showed whether there were significant differences in MOOTB fifth grade students' attitudes toward math and traditional fifth grade students' attitudes toward math relative to confidence, value, enjoyment, and motivation. This study established a problem worthy of study and a review of the relevant literature. This was a quantitative study, which utilized convenience sampling because students were not randomly assigned to groups. The four classes involved were already intact.

This chapter provides research findings on the impact of MOOTB versus traditional textbook instruction and its effect on math achievement and student attitudes towards math. The results of MAP pretest and posttest are presented in table format. Results from the survey data are also presented in table format. Data analysis includes the following topics: restatement of the problem, restatement of the research questions, restatement of the null hypotheses, description of the sample, results of statistical analysis, and summary of data collection.

The purpose of this study was to determine whether differentiated instruction via MOOTB has a significant effect on math achievement. A second purpose was to determine if there was a significant difference between MOOTB fifth grade students' attitudes toward math and traditional fifth grade students' attitudes toward math relative to confidence, value, enjoyment, and motivation.

The research questions for this study state the following:

1. Is there a difference in math achievement of fifth grade students who were taught using MOOTB and the math achievement of fifth grade students taught traditionally?

2. Is there a difference in math achievement of fifth grade students who were taught using MOOTB and the math achievement of fifth grade students taught traditionally based on race?

3. Is there a difference in math achievement of fifth grade students who were taught using MOOTB and the math achievement of fifth grade students taught traditionally based on socioeconomic status?

4. Is there a difference in math achievement of fifth grade students who were taught using MOOTB and the math achievement of fifth grade students taught traditionally based on gender?

5. Is there a significant difference between MOOTB and fifth grade students' attitudes toward math and traditional fifth grade students' attitudes toward math relative to confidence, value, enjoyment, and motivation?

The null and alternative hypotheses state:

Ho1: There is no significant difference in math achievement as measured by MAP test scores of fifth grade students taught using MOOTB and fifth grade students using traditional textbooks while controlling for pretest differences.

Ha: There is a significant difference in math achievement as measured by MAP test scores of fifth grade students taught using MOOTB and fifth grade students using traditional textbooks while controlling for pretest differences.

Ho2: There is no significant difference in math achievement as measured by MAP test scores between fifth grade students taught using MOOTB and fifth grade students using traditional textbooks while controlling for race.

Ha: There is a significant difference in math achievement as measured by MAP test scores between fifth grade students taught using MOOTB and fifth grade students using traditional textbook while controlling for race.

Ho3: There is no significant difference in math achievement as measured by MAP test scores between fifth grade students taught using MOOTB and fifth grade students using traditional textbooks while controlling for gender.

Ha: There is a significant difference in math achievement as measured by MAP test scores between fifth grade students taught using MOOTB and fifth grade students using traditional textbooks while controlling for gender.

Ho4: There is no significant difference in math achievement as measured by MAP test scores between fifth grade students taught using MOOTB and fifth grade students using traditional textbooks while controlling for socioeconomic status.

Ha: There is a significant difference in math achievement as measured by MAP test scores between fifth grade students taught using MOOTB and fifth grade students using traditional textbooks while controlling for socioeconomic status.

Ho5: There is no significant difference between MOOTB fifth grade students' attitudes toward math and traditional fifth grade students' attitudes toward math relative to confidence, value, enjoyment, and motivation.

Ha: There is a significant difference between MOOTB fifth grade students' attitudes toward math and traditional fifth grade students' attitudes toward math relative to confidence, value, enjoyment, and motivation.

Description of Sample

Introduction

This quantitative study examined the effect of differentiated instruction strategies using MOOTB versus traditional textbook instruction strategies in math on fifth grade students. This study also examined if there was a significant difference in students' attitudes toward math between the two groups relative to confidence, value, enjoyment, and motivation. The quantitative design was the quasi-experimental, non-equivalent, pretest/posttest in an effort to evaluate whether there were significant differences in the math achievement and attitudes towards math based on differentiated instruction strategies using MOOTB versus traditional textbook. A quasi-experimental design was used because all 4 groups involved were randomly assigned. The 4 groups were already intact; however, there was manipulation of the independent variable by randomly assigning 2 groups to differentiated instruction via MOOTB.

This study took effect at the school where the researcher works during the Fall of 2010 and covered a period of approximately 9 weeks. Sixty-eight fifth grade students took the MAP pretest and posttest during the fall of 2010. The two sample populations that composed the study were the MOOTB group and the traditional group. Thirty-one students were male, and 37 were female. The pretest and posttest took place in the computer lab during two of the students' regular math block. The pretest and posttest took approximately 55 minutes each to complete. The sample for the survey data included students from both instructional groups. There were 34 students in each group.

Results of Statistical Analysis

Ho1: There is no significant difference on the MAP posttest scores of fifth grade students taught using MOOTB and fifth grade students using traditional textbooks while controlling for pretest differences.

Ha: There is a significant difference on the MAP posttest scores of fifth grade students taught using MOOTB and fifth grade students using traditional textbooks while controlling for pretest differences.

Sixty-eight students took the MAP pretest and posttest. A one-way between groups (one-way ANCOVA) was calculated to examine the effect of math achievement between the two types of instructional methods. The MOOTB group consisted of 34 students and had a pretest mean of 212.53, a standard deviation of 13.067, and a posttest mean of 215.12, a standard deviation of 11.928. The traditional group consisted of 34 students and had a pretest mean of 211.79, a standard deviation of 12.973, and a posttest mean of 215.94, standard deviation of 12.085. Participants' scores on the pretest were used as a covariate in this analysis. After adjusting for pre-test scores, the main effect for math type was not significant $F(1,65) = .726$, p=.397, eta squared =.01. There were no significant differences between the two instructional groups on posttest scores. Therefore, we fail to reject the null hypothesis. The Sig. value for the covariate, pretest, is .000. This is less than .05. Therefore, the covariate is significant. It explained 1% of the variance in the posttest scores (eta squared of .01 multiplied by 100). These findings are inconsistent with research data. The implementation of MOOTB in other studies shows significant results in achievement scores compared to schools using traditional textbooks. However, the findings in this study could be attributed to the quality of instruction and years of experience by the implementer.

The Levene's test of equality of error variances revealed that the variances of the dependent variable across the two groups were equal. Tables 2, 3, and 4 list the results of this analysis.

Table 2

Descriptive Statistics

Type of instruction	Mean	Std. Deviation	*N*
MOOTB pretest	212.53	13.067	34
Traditional pretest	211.79	12.973	34
MOOTB posttest	215.12	11.928	34
Traditional posttest	215.53	12.085	34

Table 2 shows the pretest and posttest means, standard deviations, and number of participants for each instructional type.

Table 3

Tests of Between-Subjects Effect-Dependent Variable: posttest (MAP)

Source	Type III Sum of Squares	*df*	Mean Square	*F*	Sig.	Partial Eta Squared
Corrected Model	6598.314 (b)	2	3299.157	73.224	.000	.693
Intercept	688.826	1	688.826	15.288	.000	.190
Pretest	6586.784	1	6586.784	146.192	.000	.692
MType	32.711	1	32.711	.726	.397	.011
Error	2928.628	65	45.056			
Total	3168326.000	68				
Corrected Total	9526.941	67				

a. Computed using alpha = .05
b. R Squared = .693 (Adjusted R Squared = .683)

Table 4

Levene's Test of Equality of Error Variances(a)-Dependent Variable: posttest

F	*df1*	*df2*	Sig.
1.435	1	66	.235

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a Design: Intercept + Mtype + pretest

Ho2: There is no significant difference in math achievement as measured by MAP test scores between fifth grade students taught using MOOTB and fifth grade students using traditional textbooks while controlling for race.

Ha: There is a significant difference in math achievement as measured by MAP test scores between fifth grade students taught using MOOTB and fifth grade students using traditional textbooks while controlling for race.

Another one-way between subjects analysis of covariance (one-way ANCOVA) was calculated to examine the effect of race on the posttest. There were a total of thirty-four students in each instructional group. The MOOTB group consisted of 24 African Americans, 3 Caucasians, and 7 Hispanics. The traditional group consisted of 18 African Americans, 8 Caucasians, 6 Hispanics, and 2 Pacific Islanders. The MOOTB group had a mean of 215.18 and the traditional group had a mean of 215.88. After adjusting for pretest scores, the main effect for race was not significant $F(1,65) = .275$, $p=.602$, eta squared =.00. There was also no significant effect on math achievement on posttest scores based on race between the two instructional groups $F(1,65) = .058$, $p = .810$, eta squared = .00. Therefore, we fail to reject the null hypothesis. Table 5 lists the frequencies and percentages for race. These research findings are inconsistent with research studies. Caucasians tend to score higher than African Americans and Hispanics. The results from this study could be attributed to the fact that the Caucasian group was too small to show a significant difference in achievement scores. Table 6 lists the results of the analysis.

Table 5

Frequencies and Percentages for Race of 5th Grade Math Students by Type of Math Instruction

Type of Instruction	African American		Caucasian		Hispanic		Pacific	
	f	%	*f*	%	*f*	%	*f*	%
MOOTB	24	70.6	3	8.8	7	20.6	0	0
Traditional Textbook	18	52.9	8	23.5	6	17.6	2	5.9

Table 5 shows that there were 24 (70.6%) African American, 3 (8.8%) Caucasian, 7 (20.6%), Hispanic, and 0 (0%) Pacific Islander students taught using the MOOTB method of teaching. The table also shows that there were 18 (52.9%) African American, 8 (23.5%) Caucasian, 6 (17.6%) Hispanic, and 2 (5.9%) Pacific Island students taught using the traditional textbook.

Table 6

Test of Between-Subjects Effect-Dependent Variable: posttest (MAP)

Source	Type III Sum of Squares	*df*	Mean Square	*F*	Sig.	Partial Eta Squared
Corrected Model	51.641(b)	2	25.820	.177	.838	.005
Intercept	928728.345	1	928728.345	6371.021	.000	.990
Mtype	8.458	1	8.458	.058	.810	.001
Race	40.111	1	40.111	.275	.602	.004
Error	9475.301	65	145.774			
Total	3168326.000	68				
Corrected Total	9526.941	67				

a Computed using alpha = .05

b R Squared = .005 (Adjusted R Squared = -.025)

Ho3: There is no significant difference in math achievement as measured by MAP test scores between fifth grade students taught using MOOTB and fifth grade students using traditional textbooks while controlling for gender.

Ha: There is a significant difference in math achievement as measured by MAP test scores between fifth grade students taught using MOOTB and fifth grade students using traditional textbooks while controlling for gender.

A one-way between subjects analysis of covariance (one-way ANCOVA) was calculated to examine the effect of gender on the posttest. There were 34 students in each instructional group. The MOOTB group consisted of 12 males and 22 females. The traditional group consisted of 19 males and 15 females. The MOOTB group had a mean of 214.87 and the traditional group had a mean of 216.19. After adjusting for pretest scores, there was no significant effect between gender and type of instruction. The main effect for gender was not significant $F(1,65) = .626$, $p = .432$, eta squared =.010. The main effect for type of instruction based on gender was not significant $F(1,65) = .193$, $p = .662$, eta squared .003. Therefore, we fail to reject the null hypothesis. This finding was inconsistent with research data. Females tend to score significantly higher than males. They are usually superior to males (Rubin, 1993). Table 7 lists the frequencies and percentages for gender. Table 8 lists the results of the analysis.

Table 7

Frequencies and Percentages for Gender of Fifth Grade Math Students by Type of Math Instruction

Type of Instruction	Male		Female	
	f	%	*f*	%
MOOTB	12	38.7	22	59.5
Traditional Textbook	19	61.3	15	40.5

Table 7 shows that there were 12 (38.7%) male and 22 (59.5%) female students instructed in the MOOTB group. There were 19 (61.3%) male and 15 (40.5%) female students instructed using the tradition textbook.

Table 8

Test of Between-Subjects Effect-Dependent Variable: posttest (MAP)

Source	Type III Sum of Squares	*df*	Mean Square	*F*	Sig.	Partial Eta Squared
Corrected Model	102.347(b)	2	51.174	.353	.704	.011
Intercept	276458.181	1	276458.181	1906.690	.000	.967
Mtype	28.004	1	28.004	.193	.662	.003
Gender	90.818	1	90.818	.626	.432	.010
Error	9424.594	65	144.994			
Total	3168326.000	68				
Corrected Total	9526.941	67				

a Computed using alpha = .05
b R Squared = .011 (Adjusted R Squared = -.020)

Ho4: There is no significant difference in math achievement as measured by MAP test scores between fifth grade students taught using MOOTB and fifth grade students using traditional textbooks while controlling for socioeconomic status.

Ha: There is a significant difference in math achievement as measured by MAP test scores between fifth grade students taught using MOOTB and fifth grade students using traditional textbooks while controlling for socioeconomic status.

Another one-way between groups analysis of covariance (one-way ANCOVA) was calculated to examine the effect of socioeconomic status on the posttest. There were thirty-four students in each instructional group. In the MOOTB group, 30 students received free meals, and 4 students paid for their meal. The traditional group had 25 students who received free meals, 5 students paid a reduced fee, and 4 students paid for meals. The estimated marginal means for socioeconomic status for the MOOTB group was 215.54 and for the traditional group was 215.52. The results showed that the main effect for socioeconomic status was statistically significant $F(1,65) = 7.55$, $p = .008$, eta squared =.104. The null hypothesis was rejected. The study findings are consistent with research data. Students from low socioeconomic communities are less likely to have financial resources they need therefore, children tend to develop skills slower than children from higher socioeconomic communities. Table 9 lists the frequencies and percentages for socioeconomic status. Table 10 lists the results of the analysis.

Table 9

Frequencies and Percentages for Socioeconomic Status of Fifth Grade Math Students by Type of Math Instruction

Type of Instruction	Free		Reduced		Paid	
	f	%	*f*	%	*f*	%
MOOTB	30	88.2	0	0	4	11.8
Traditional Textbook	25	73.5	5	14.7	4	11.8

Table 9 shows the frequency and percentages of MOOTB and Traditional textbook groups based on free and reduced meals.

Table 10

Test of Between-Subjects Effect-Dependent Variable: posttest (MAP)

Source	Type III Sum of Squares	*df*	Mean Square	*F*	Sig.	Partial Eta Squared
Corrected Model	1002.272(b)	2	501.136	3.821	.027	.105
Intercept	605007.446	1	605007.446	4613.139	.000	.986
Mtype	.006	1	.006	.000	.994	.000
SES	990.742	1	990.742	7.554	.008	.104
Error	8524.594	65	131.149			
Total	3168326.000	68				
Corrected Total	9526.941	67				

a Computed using alpha = .05
b R Squared = .105 (Adjusted R Squared = .078)

Ho5: There is no significant difference between MOOTB fifth grade students' attitude toward math and traditional fifth grade students' attitude toward math relative to confidence, value, enjoyment, and motivation.

Ha: There is a significant difference between MOOTB fifth grade students' attitude toward math and traditional fifth grade students' attitude toward math relative to confidence, value, enjoyment, and motivation.

A univariate analysis of variance was conducted to compare the effectiveness of student attitudes towards math between MOOTB and traditional textbook instruction based on survey responses. Students completed the survey at home. There were 40 items on the survey in which students responded to using the following codes: A = strongly disagree, B = disagree, C = neutral, D = agree, and E = strongly agree. The survey items showed if there was a significant difference in students' attitudes toward math relative to confidence, value, enjoyment, and motivation.

There were 24 survey responses from the MOOTB group, (6 from males, and 18 from females) and 19 survey responses from the traditional group (8 from males, and 11 from females). Based on survey responses relative to confidence (items 9-22 and 40), the MOOTB group had a mean of 42.83 and the traditional group had a mean of 42.68. The total mean for both groups was 42.77. The results showed that there were no significant differences in the students' confidence toward math based on type of math instruction $F(1,39) = .088$, $p = .769$, eta squared = .002. Therefore, we fail to reject the null hypothesis. Tables 11 and 12 list the results of this analysis.

Table 11

Test of Between-Subjects Effects-Dependent Variable: confidence

Source	Type III Sum of Squares	*df*	Mean Square	*F*	Sig.	Partial Eta Squared
Corrected Model	60.921(a)	3	20.307	.382	.766	.029
Intercept	66035.467	1	66035.467	1242.494	.000	.970
Math	4.654	1	4.654	.088	.769	.002
Gender	.072	1	.072	.001	.971	.000
Math* Gender	60.660	1	60.660	1.141	.292	.028
Error	2072.754	39	53.148			
Total	80783.000	43				
Corrected Total	2133.674	42				

a R Squared = .029 (Adjusted R Squared = -.046)

Table 12

Pairwise Comparisons-Dependent Variable: confidence

(I) type of instruction	(J) type of instruction	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a) Lower Bound	Upper Bound
MOOTB	traditional	-.714	2.413	.769(*)	-5.594	4.166
traditional	MOOTB	.714	2.413	.769(*)	-4.166	5.594

Based on estimated marginal means
* The mean difference is not significant at the .05 level.
a Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

A univariate analysis of variance was conducted to compare the effectiveness of students' attitudes toward math between MOOTB and traditional textbook instruction relative to value. There were 24 survey responses from the MOOTB group, (6 from males, and 18 from females) and 19 survey responses from the traditional group (8 from males, and 11 from females). Based on survey responses relative to value (items 1, 2, 4, 5, 6, 7, 8, 35, 36, and 39), the MOOTB group had a mean of 44.25 and the traditional group had a mean of 43.58. The total mean for both groups was 43.95. The results showed that there were no significant differences in how students' value math based on type of math instruction $F(1,39) = .194$, $p = .662$, eta squared = .005. Therefore, we fail to reject the null hypothesis. Tables 13 and 14 list the results of this analysis.

Table 13

Test of Between-Subjects Effects-Dependent Variable: value

Source	Type III Sum of Squares	*df*	Mean Square	*F*	Sig.	Partial Eta Squared
Corrected Model	7.375(a)	3	2.458	.088	.966	.007
Intercept	70713.453	1	70713.453	2533.528	.000	.985
Math	5.407	1	5.407	.194	.662	.005
Gender	2.598	1	2.598	.093	.762	.002
Math* Gender	.004	1	.004	.000	.990	.000
Error	1088.532	39	27.911			
Total	80783.000	43				
Corrected Total	1095.907	42				

a R Squared = .007 (Adjusted R Squared = -.070)

Table 14

Pairwise Comparisons-Dependent Variable: value

(I) type of instruction	(J) type of instruction	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a) Lower Bound	Upper Bound
MOOTB	traditional	.770	1.748	.662(*)	-2.767	4.306
traditional	MOOTB	-.770	1.748	.662(*)	-4.306	2.767

Based on estimated marginal means
* The mean difference is not significant at the .05 level.
a Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

A univariate analysis of variance was conducted to compare the effectiveness of student attitude towards math between MOOTB and traditional textbook instruction relative to enjoyment. There were 24 survey responses from the MOOTB group, (6 from males, and 18 from females) and 19 survey responses from the traditional group (8 from males, and 11 from females). Based on survey responses relative to enjoyment (items 3, 24, 25, 26, 27, 29, 30, 31, 37, and 38), the MOOTB group had a mean of 41.17 and the traditional group had a mean of 36.84 The total mean for both groups was 39.26. The results showed that there was a significant differences in the students' enjoyment toward math based on type of math instruction $F(1,39) = 6.365$, $p = .016$, eta squared = .140. The MOOTB group enjoyed math more than the traditional group. The null hypothesis was rejected relative to enjoyment. This finding is consistent with research studies. The results in this finding are attributed to the fact that when students are actively involved, they enjoy what they are learning. Tables 15 and 16 list the results of this analysis.

Table 15

Test of Between-Subjects Effects-Dependent Variable: enjoyment

Source	Type III Sum of Squares	*df*	Mean Square	*F*	Sig.	Partial Eta Squared
Corrected Model	202.533(a)	3	67.511	2.247	.098	.147
Intercept	55832.186	1	55832.186	1858.448	.000	.979
Math	191.206	1	191.206	6.365	.016	.140
Gender	.603	1	.603	.020	.888	.001
Math* Gender	3.646	1	3.646	.121	.729	.003
Error	1171.653	39	30.042			
Total	67638.000	43				
Corrected Total	1374.186	42				

a R Squared = .147 (Adjusted R Squared = .082)

Table 16

Pairwise Comparisons-Dependent Variable: enjoyment

(I) type of instruction	(J) type of instruction	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a)	
					Lower Bound	Upper Bound
MOOTB	traditional	4.576	1.814	.016(*)	.907	8.246
traditional	MOOTB	-4.576	1.814	.016(*)	-8.246	-.907

Based on estimated marginal means
* The mean difference is significant at the .05 level.
a Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

A univariate analysis of variance was conducted to compare the effectiveness of students' attitudes toward math between MOOTB and traditional textbook instruction relative to motivation. There were 24 survey responses from the MOOTB group, (6 from males, and 18 from females) and 19 survey responses from the traditional group (8 from males, and 11 from females). Based on survey responses relative to motivation (items 23, 28, 32, 33, and 34), the MOOTB group had a mean of 18.83 and the traditional group had a mean of 17.32. The total mean for both groups was 18.16. The results showed that there were no significant differences in the students' motivation toward math based on type of math instruction $F(1,39) = 1.932$, $p = .172$, eta squared = .047. Therefore, we fail to reject the null hypothesis. Tables 17 and 18 list the results of this analysis.

Table 17

Test of Between-Subjects Effects-Dependent Variable: motivation

Source	Type III Sum of Squares	*df*	Mean Square	*F*	Sig.	Partial Eta Squared
Corrected Model	36.704(a)	3	12.235	1.239	.309	.087
Intercept	12051.358	1	12051.358	1220.291	.000	.969
Math	19.082	1	19.082	1.932	.172	.047
Gender	7.693	1	7.693	.779	.971	.000
Math* Gender	4.419	1	4.419	.447	.507	.011
Error	385.157	39	9.876			
Total	14607.000	43				
Corrected Total	421.860	42				

a R Squared = .087 (Adjusted R Squared = .017)

Table 18

Pairwise Comparisons-Dependent Variable: motivation

(I) type of instruction	(J) type of instruction	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a) Lower Bound	Upper Bound
MOOTB	traditional	1.446	1.040	.172(*)	-.658	3.549
traditional	MOOTB	-1.446	1.040	.172(*)	-3.549	658

Based on estimated marginal means
* The mean difference is not significant at the .05 level.
a Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

The following table 19 lists the Cronbach alpha coefficient for each scale of the attitude survey and the results of the analysis.

Table 19

Reliability Statistics

Scale	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items
Confidence	.633	.603
Value	.803	.815
Enjoyment	.766	.780
Motivation	.325	.401

Scale Statistics

Scale	Mean	Variance	Std. Deviation	*N*
Confidence	42.77	50.802	7.128	15
Value	43.95	26.093	5.108	10
Enjoyment	39.26	32.719	5.720	10
Motivation	18.16	10.044	3.169	5

Summary of Results

Table 20 summarizes the findings from this study.

Null Hypotheses	Results
Ho1 (one-way ANCOVA)	There was no significant difference on MAP posttest scores of fifth grade students taught using MOOTB and fifth grade students using traditional textbook. Conclusion was to fail to reject the null hypothesis.
Ho2 (one-way ANCOVA)	There was no significant difference in MAP test scores of fifth grade students taught via MOOTB and fifth grade students taught traditionally while controlling for race. Conclusion was to fail to reject the null hypothesis.
Ho3 (one-way ANCOVA)	There was no significant difference in MAP test scores of fifth grade students taught via MOOTB and fifth grade students taught traditionally while controlling for gender. Conclusion was to fail to reject the null hypothesis.
Ho4 (one-way ANCOVA)	There was a significant difference in MAP test scores of fifth grade students taught via MOOTB and fifth grade students taught traditionally while controlling for socioeconomic status. The null hypothesis was rejected.
Ho5 (Univariate Analysis of Variance) A. Confidence	There were no significant differences found in fifth grade MOOTB and traditional fifth grade students' attitudes. Conclusion was to fail to reject the null hypothesis relative to confidence.
B. Value	There were no significant differences found in fifth grade MOOTB and traditional fifth grade students' attitudes. Conclusion was to fail to reject the null hypothesis relative to value.
C. Enjoyment	There was a significant difference in fifth grade MOOTB and traditional fifth grade students' attitudes toward math. Null hypothesis was rejected relative to enjoyment.
D. Motivation	There were no significant differences found in fifth grade MOOTB and traditional fifth grade students' attitudes. Conclusion was to fail to reject the null hypothesis relative to motivation.

Section 5: Recommendations, Summary, and Conclusions

Introduction

President Bush signed into law the NCLB on January 8, 2002. The purpose of this law was to focus on student achievement in an effort to raise test scores and improve the level of instruction in the classroom. President Bush wanted to ensure that all children receive a high-quality education so that no child is left behind. The NCLB Act holds districts and schools accountable for student achievement. Schools are responsible for making sure that children are making progress towards performing at the proficient and advanced levels on state assessments. School performance on state assessments determines AYP.

Since testing has become a central part in the academic success of students, society has begun to consider good test scores as a major goal of schooling. It is important that teachers observe strategies that engage students. Differentiating instruction is a strategy that helps engage students because students are given multiple ways of taking in information and expressing what they have learned. The purpose of this quantitative study was to determine whether differentiated instruction via MOOTB had a significant effect on math achievement. A second purpose was to determine if there was a significant difference between MOOTB and fifth grade students' attitudes toward math and traditional fifth grade students' attitudes toward math relative to confidence, value, enjoyment, and motivation.

The sample consisted of fifth grade students in one elementary school located in a southern state. Sixty-eight students participated in the study. The study consisted of two groups, MOOTB and traditional textbook. There were 34 students in each group. The researcher instructed each group using lessons from MOOTB and traditional textbook. Students completed a MAP computerized pretest and posttest during the school district's regular MAP testing window. Students were taken to the computer lab for testing that took approximately 55 minutes. Students also completed a five-point attitude towards math questionnaire developed by Dr. Martha Tapia. A research assistant collected the questionnaires. Students had two weeks to return questionnaire. The research assistant turned all questionnaires over to the researcher. Results from the pretest and posttest were entered into the SPSS 19.0 data file. The null hypotheses were tested using the one-way analysis of covariance for the MAP data and the univariate analysis of variance for the survey data.

The following questions were addressed in this research study:

1. Is there a difference in math achievement as measured by MAP posttest scores of fifth grade students who were taught using MOOTB and the math achievement of fifth grade students taught traditionally while controlling for pretest differences?

2. Is there a difference in math achievement of fifth grade students who were taught using MOOTB and the math achievement of fifth grade students taught traditionally based on race?

3. Is there a difference in math achievement of fifth grade students who were taught using MOOTB and the math achievement of fifth grade students taught traditionally based on socioeconomic status?

4. Is there a difference in math achievement of fifth grade students who were taught using MOOTB and the math achievement of fifth grade students taught traditionally based on gender?

5. Is there a significant difference between MOOTB and fifth grade students' attitude toward math and traditional fifth grade students' attitude toward math relative to confidence, value, enjoyment, and motivation?

Summary of Findings

For Research Question 1, a one-way between subjects analysis of covariance showed that before implementation, the MOOTB group had a MAP pretest mean of 212.53, SD of 13.07, and the traditional group had a MAP pretest mean of 211.79, SD of 12.97. After implementation, the MOOTB group had a MAP posttest mean of 215.12, SD of 11.93, and the traditional group had a MAP posttest mean of 215.94, SD of 12.09. The results showed that there were no significant differences on the MAP posttest scores of fifth grade students taught using MOOTB versus traditional textbook instruction.

Another one-way between subjects analysis of covariance was used for research question 2, which was used to examine the effect of student achievement while controlling for race. The MOOTB group had a mean of 215.18 and the traditional group had a mean of 215.88. The results showed no significant difference in MAP scores while controlling for race. A one-way between subjects analysis of covariance used for research question three showed no significant difference in MAP test scores while controlling for gender, MOOTB mean of 214.87 and traditional mean of 216.19. However, research question four showed a significant difference in MAP scores while controlling for socioeconomic status.

Results from the survey data showed that there were no significant differences in students' attitudes toward math relative to confidence, value, and motivation. However, there were significant differences in students' attitudes toward math relative to enjoyment. The MOOTB group enjoyed math more than the traditional group.

Interpretations of Findings

In this section, the research questions are listed and an interpretation given for each.

1. Is there a difference in math achievement as measured by MAP posttest scores of fifth grade students who were taught using MOOTB and the math achievement of fifth grade students taught traditionally?

Quantitative data from MAP tests revealed that the posttest means from both instructional groups were not significant. The MAP posttest mean for the MOOTB group was 215.12 and the traditional group mean was 215.94. Students in the traditional group scored as well as students in the MOOTB group while controlling for pretest differences. The researcher believes that this could be attributed to several factors. First, testing environments were the same for each group. All students were given the amount of time needed to complete the test. Secondly, the researcher was also the implementer, has been in the educational field for 19 years, and brings many experiences to the classroom. Thirdly, the researcher believes that teaching style is very important. Knowing students and their need helps build a strong educational foundation for all children.

2. Is there a significant difference in math achievement as measured by MAP test scores between fifth grade students taught using MOOTB and fifth grade students using traditional textbooks while controlling for race?

One-way between subjects analysis of covariance (one-way ANCOVA) was calculated to examine the effect of race on the posttest, covarying out the effect of the pretest. The main effect of race was not significant, meaning that the four ethnic groups, (African American, Caucasian, Hispanic, and Pacific Islander) did not show any significant differences in math achievement. The findings suggest that based on the type of instruction, students did not score significantly higher than any other ethnic group. One factor that could have possibly contributed to these findings is that the researcher, being the implementer, was very thorough in providing quality instruction to both groups. The researcher was aware of each individual needs and ensured that those needs were being met. Secondly, the researcher had access to individual MAP data and used that data to differentiated instruction effectively.

3. Is there a significant difference in math achievement as measured by MAP test scores between fifth grade students taught using MOOTB and fifth grade students using traditional textbooks while controlling for gender?

Another one-way between subjects analysis of covariance (one-way ANCOVA) was calculated to examine the effect of gender on the posttest, covarying out the effect of the pretest. The main effect for gender was not significant based on the type of instruction. In other words, there were no differences in math achievement of males compared to females based on type of instruction. The researcher believes that this is attributed to the fact that the researcher was also the implementer and noticed that the males were just as much involved in the learning process as the females. Teaching style would also be a critical factor when providing quality instruction. The researcher communicated with males and females and was aware of individual needs.

4. Is there a significant difference in math achievement as measured by MAP test scores between of fifth grade students taught using MOOTB and fifth grade

students using traditional textbooks while controlling for socioeconomic status?

A one-way analysis of covariance (ANCOVA) was calculated to examine the effect of socioeconomic status on the posttest, covarying out the effect of the pretest. Test data revealed that there were no significant effect in math achievement based on type of instruction however, the main effect of socioeconomic status was statistically significant. Students from the higher socioeconomic environments scored higher than those from the lower socioeconomic environments. The first consideration to this finding is the students' family environment. Students coming from families with low socioeconomic environments may not have the financial resources or the time needed to spend with their children (Aikens & Barbarian, 2008).

5. Is there a significant difference between MOOTB fifth grade students' attitudes towards math and traditional fifth grade students' attitudes toward math relative to confidence, value, enjoyment, and motivation?

A univariate analysis of variance compared the effectiveness of student attitudes toward math between MOOTB and traditional textbook. Based on survey questions dealing with confidence, value, and motivation both groups attitudes showed no difference in how students felt about math. Both groups tend to feel confident toward math instruction, value mathematics, and are motivated. However, survey data revealed a significant difference based on type of instruction relative to enjoyment. Students in the MOOTB group tend to enjoy math better. The researcher believes that this is because students in the MOOTB group are given more hands-on learning as well as working cooperatively in groups. Students also receive adequate feedback and reinforcement since the teacher is constantly monitoring and questioning groups. Traditional teaching is more teacher-directed and students did not receive the hands-on learning and do not receive as much feedback as the instruction that is guided by MOOTB. Muirhead (2001) stated, “If learners do not receive adequate teacher feedback and reinforcement, students will not always know whether they possess an accurate knowledge of their subject matter” (p. 108). Providing feedback in a timely manner helps students to grow academically.

Implications for Social Change

With the implementation of the NCLB Act, educators are responsible in ensuring that all students receive high-quality education. Research considered from this study help educators determine if using differentiating instruction via MOOTB has a significant effect on student achievement. In addition, this study considered students’ attitudes toward math relative to confidence, value, enjoyment, and motivation depending on the type of math instruction they received. This study also has the potential to provide a new way of teaching mathematics by improving student achievement for all learners within mixed ability classrooms.

This study focused on MOOTB versus traditional instruction and the impact on math achievement and student attitudes. This study is important because a Title I school located in a southern state is required to use MOOTB as a method of instruction for teaching mathematics. Tomlinson (2008) noted that differentiating instruction is critical to student success because children of the same age learn differently. When teachers accommodate for individual differences, students can learn at their own level (Tomlinson, 2008). MOOTB provides a hands-on learning approach that allows students to explore and demonstrate mathematical ideas using concrete materials (Moss, 2005).

The significance of this research study is that it provides the school district, administrative team, leadership team, teachers, parents, and students with information about the impact MOOTB versus traditional instruction have on math achievement and students' attitudes relative to confidence, value, motivation, and enjoyment. Since limited schools are using MOOTB, this research study will help other districts in deciding whether they would be willing to use MOOTB as a new method.

Recommendations for Action

Based on results from this study, differentiating instruction via MOOTB does have some impact on student achievement versus traditional textbook instruction. While MOOTB instructional method did not have a significant effect on MAP posttest results when comparing to the traditional textbook, both instructional methods showed improvements in student achievement. The researcher believes that differentiating instruction via MOOTB is an effective method for teaching mathematics because it gives students that hands-on learning and more opportunities to communicate with their classmates versus the traditional textbook.

Results from this research study support the literature on the importance of using MOOTB. One of the findings of the study is that students in the MOOTB group enjoyed mathematics better than the traditional group. A response to the study is to continue to use MOOTB. When students interact with one another, they become active participants and enjoy working together. Working with the teacher keeps students more attentive and actively involved. Answering questions and giving feedback provides a connection between student and teacher that probably would not be there if students were just simply working problems using a textbook. Akey (2006) stated that schools should be designed so that students' feelings of accomplishment are enhanced in order to keep students engaged in the school and learning. The researcher believes if students are given the opportunity to choose whether they want to participate in MOOTB or traditional instruction, most of the students would choose MOOTB.

Another important finding of the study is that socioeconomic status was significant. Depending on free, reduced, and paid meals, there was an effect on math achievement. A response to this is that socioeconomic status does affect our society. Families from low socioeconomic communities are less likely to have the financial resources or time to provide their child with the academic support needed (Aikens & Barbarian, 2008). Even research supports the fact that children from low socioeconomic communities develop skills at a slower rate compared to children from a higher socioeconomic community (Aikens & Barbarian, 2008). The researcher believes that MOOTB would be more beneficial to students who come from lower socioeconomic environments because through communication and investigations, students are developing concepts by working together and learning from others and then taking ownership of that new knowledge.

Recommendations for Further Study

This study helped answer questions about the MOOTB versus traditional textbook instruction and the impact of student achievement and attitudes toward math. There were some limitations to the study. First, when conducting experimental studies, sometimes a researcher may have problems in collecting data. This study depended on the willingness of students to complete survey, accuracy of the student responses, and the truthfulness in their responses on the survey data. Secondly, since the participation in the survey data was strictly voluntary, of the sixty-eight surveys distributed, forty-three were returned. Thirdly, the manipulation of the independent variable by randomly assigning two groups to have differentiated instruction via MOOTB and two groups to have traditional instruction limited the study to be a quasi-experimental study rather than an experimental study.

Fourthly, this study originally was going to compare students' attitudes toward math based on achievement scores. However, the researcher could not link the achievement scores with survey data, therefore, a univariate analysis of variance test had to be run for the survey data to determine if there was a significant difference between MOOTB fifth grade students' attitudes toward math and traditional fifth grade students' attitude toward math relative to confidence, value, enjoyment, and motivation. Further research could be done to determine how well students' attitudes towards math predict their academic achievement. In addition, further study could be done by looking at other schools similar to the type of school used for this research study to determine if there are any differences in attitudes toward math based on achievement scores. This would make the study more generalizable to other populations. Since the MOOTB group enjoyed math more than the traditional group, a study could also be done to determine what teachers should implement in their instructional method to help traditional learners enjoy math more. Traditional learning is more textbook oriented, therefore, another study could be done to determine if traditional learning students are interested in interacting with other students, and if so, which interaction has a greater impact on math achievement, student-teacher interaction or student-to-student interaction. Since this research study covered approximately 9 weeks, more investigations covering a longer time would be beneficial.

Conclusion

The purpose of this research study was to determine whether differentiated instruction via MOOTB has a significant effect on math achievement. A second purpose was to determine if there were significant differences between MOOTB fifth grade students' attitudes and traditional fifth grade students' attitudes toward math relative to confidence, value, enjoyment, and motivation. While there were no significant differences in MAP posttest results for instructional type, there were growth in each group. This study supports the research on the importance of differentiating instruction via MOOTB. There was a significant difference in students' attitudes toward math relative to enjoyment. The MOOTB group enjoyed math more than the traditional group. This is supported by research because when students can interact with one another, they become active participants and enjoy working together. Students are more likely to retain ideas and concepts. There was also a significant difference in socioeconomic status, which is also supported by research. Students who come from low socioeconomic environments develop skills at a slower rate compared to students who come from a higher socioeconomic environment.

When implementing differentiated instruction via MOOTB, students develop the ability in making mathematical connections. Educators are helping students discover, explore, and create multiple ways of learning.

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Appendix A: Attitudes Toward Mathematics Inventory

☐ Parents: My child's completion of this survey represents my consent.

☐ Students: My completion of this survey represents my assent.

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

PLEASE USE THESE RESPONSE CODES

(A) = Strongly Disagree
(B) = Disagree
(C) = Neutral
(D) = Agree
(E) = Strongly Agree

_____Boy _____Girl

1. ________ Mathematics is a very worthwhile and necessary subject.
2. ________ I want to develop my mathematical skills.
3. ________ I get a great deal of satisfaction out of solving a mathematics problem.
4. ________ Mathematics helps develop the mind and teaches a person to think.
5. ________ Mathematics is important in everyday life.
6. ________ Mathematics is one of the most important subjects for people to study.
7. ________ Middle school math courses would be very helpful no matter what I decide to study.
8. ________ I can think of many ways that I use math outside of school.
9. ________ Mathematics is one of my most dreaded subjects.
10. ________ My mind goes blank and I am unable to think clearly when working with mathematics.
11. ________ Studying mathematics makes me feel nervous.
12. ________ Mathematics makes me feel uncomfortable.
13. ________ I am always under a terrible strain in a math class.
14. ________ When I hear the word mathematics, I have a feeling of dislike.
15. ________ It makes me nervous to even think about having to do a mathematics problem.
16. ________ Mathematics does not scare me at all.
17. ________ I have a lot of self-confidence when it comes to mathematics.
18. ________ I am able to solve mathematics problems without too much difficulty.
19. ________ I expect to do fairly well in any math class I take.
20. ________ I am always confused in my mathematics class.
21. ________ I feel a sense of insecurity when attempting mathematics.
22. ________ I learn mathematics easily.
23. ________ I am confident that I could learn advanced mathematics.

24. ________I have usually enjoyed studying mathematics in school.
25. ________Mathematics is dull and boring.
26. ________I like to solve new problems in mathematics.
27. ________I would prefer to do an assignment in math than to write an essay.
28. ________ I would like to avoid using mathematics in middle school.
29. ________I really like mathematics.
30. ________ I am happier in a math class than in any other class.
31. ________Mathematics is a very interesting subject.
32. ________ I am willing to take more than the required amount of mathematics.
33. ________ I plan to take as much mathematics as I can during my education.
34. ________ The challenge of math appeals to me.
35. ________ I think studying advanced mathematics is useful.
36. ________ I believe studying math helps me with problem solving in other areas.
37. ________ I am comfortable expressing my own ideas on how to look for solutions to a difficult problem in math.
38. ________ I am comfortable answering questions in math class.
39. ________ A strong math background could help me in my professional life.
40. ________ I believe I am good at solving math problems.

Appendix B: District Research Application

RESEARCH, EVALUATION, & ACCOUNTABILITY

GENERAL INFORMATION
Researcher's Status: _____Professional: Research is sponsored by universities, governmental agencies, or like agencies
X Student: Research is sponsored by a college or university and supervised by a faculty member

Date of submission:

Title of Proposal: The Impact of Differentiated Versus Traditional Instruction on Math Achievement and Student Attitudes

Project Start and End Dates: During the 2nd grading period – November 2010 through January 2011

Principal Researcher's Name: Valerie Gamble

Current Position: Fifth Grade Math Teacher

RESEARCH OUTLINE

1. Purpose and basis of the study and how this study will contribute to educational advancement in GCS

The purpose of this quantitative study is to determine if there is a significant difference in math achievement of fifth grade students taught using MOOTB and fifth grade students taught traditionally. A second purpose of this quantitative study is to determine if there is a difference in the attitudes toward math of fifth grade students taught by MOOTB and the attitudes toward math of fifth grade students taught traditionally relative to confidence, value, enjoyment, and motivation.

Math out of the Box is an inquiry based approach and provides a way of teaching mathematics using a differentiated approach to learning. From this study, the researcher hopes to show gains in student achievement and more schools would be willing to adopt the program in an effort to continue improving student achievement.

2. Brief summary of literature review and statement of the theoretical basis/framework proposed

The literature review establishes the theoretical basis of the study which focuses on differentiated instruction as well as other conceptual framework that align with the work of Tomlinson, Gardner, Vygotsky, Bruner, Piaget and differentiated instruction using an inquiry-based approach to teaching math versus a traditional textbook. The literature review discusses the effectiveness of differentiated instruction, the advantages and disadvantages of differentiated instruction, traditional classrooms versus differentiated classrooms, and studies in differentiated instruction. The importance of using Math out of the Box, how MOOTB is different from other inquiry-based programs, benefits of MOOTB, and studies of MOOTB are discussed. The literature review also discusses several factors that affect student achievement.

3. Procedures that will be used in the District

Data collection schedule and type of data collected:

After receiving approval from the research committee, the researcher will then submit a letter to the building principal, assistant principal, and a copy of the committee's approval form. Upon receiving approval from the principal, an information letter and consent form will be sent home to parents of those students involved explaining the purpose of the study and requesting that their child be a participant in the study.

The researcher will make sure that parents fill out a consent form granting their child's permission to participate. Students will not be penalized if parents choose not to have their child participate. Participants will also be required to complete an assent form in order to participate. Participants will be informed that being a part of the research study is strictly voluntary. The researcher will keep all consent forms in a locked cabinet. The data collection will take approximately 9 weeks. MAP results and survey results will be collected and analyzed using the Statistical Package for Social Sciences (SPSS) program. Survey results will be analyzed by using the univariate analysis of data statistical test.

Selection/sampling method for participants/schools(Specifically who, how many and which people, schools will be involved

The sample will consist of approximately 95 fifth grade students. It will be drawn from the school where the researcher works. The researcher will use convenience sampling. The sample will also consist of 20 fifth grade students who will be randomly selected for the interviewing process. It will also be drawn from the school where the researcher works.

Impact on instructional and human time at the schools w/rationale (total time required for all participants including pre-visits,etc.)

The study will not take any instructional time away from students. Each math block is 50 minutes and students will be instructed during the total time. The study will include one 9 week grading period.

What participants will be asked to do

Participants will be asked to take home parent consent letter and return to the research assistant. Participants will also be asked to complete an assent form. For the quantitative sample, participants will be asked to take a pre and posttest (MAP), and complete a survey.

Potential risks and benefits to the participants

There are no potential risks to any of the participants. Students will receive instruction that will provide them with multiple ways of taking in information and expressing what they have learned. Students can use different approaches in answering or solving problems.

How and to whom data will be reported

Data will be entered into a statistical program, SPSS, and this program will be used to analyze the results. Testing data will be reported by the researcher to the school district and the school's principal. The researcher will submit study results to the school district and make an appointment with the principal or assistant principal to discuss study results.

4. Hypotheses of the study

Null Hypotheses

Ho1: There is no significant difference in math achievement of fifth grade students taught using MOOTB and fifth grade students taught traditionally.

Ho2: There is no significant difference in math achievement of fifth grade students who were taught using MOOTB and the math achievement of fifth grade students taught traditionally based on race.

Ho3: There is no significant difference in math achievement of fifth grade students who were taught traditionally based on gender.

Ho4: There is no significant difference in math achievement of fifth grade students who were taught using MOOTB and the math achievement of fifth grade students taught traditionally based on socioeconomic status.

Ho5: There is no significant difference between MOOTB fifth grade students' attitude toward math and traditional fifth grade students' attitude toward math relative to confidence, value, enjoyment, and motivation.

5. Summary of research design including statistical analysis procedures

The quantitative design will be the quasi-experimental, non-equivalent, pretest-posttest in an effort to evaluate whether there will be significant differences in academic achievement. The null hypotheses will be tested using the one-way analysis of covariance (one-way ANCOVA). The univariate analysis of variance will be used to determine the difference between MOOTB fifth grade students' attitudes and traditional fifth grade students' attitudes toward math relative to confidence, value, enjoyment, and motivation.

6. Materials participants receive/use (*Attach one copy of each survey, test validation info, informed consent form(s), etc.)*

7. Source of research funds - NA

8. State whether this is a single study, or one of a series planned or contemplated. If a series, briefly outline plan and timeline.

This is a single study.

9. If this is a student research project, submit the following:

A letter of support from a research sponsor (e.g., college/university faculty member, agency staff member) and a copy of the IRB proposal approval form.

Appendix C: Parent/Guardian Information on Research Study

Dear Parents/Guardians,

I am currently pursuing a doctorate degree in Teacher Leadership at Walden University. I am focusing my doctoral study on understanding the effect of instruction on student learning in math and attitudes towards math of fifth grade students in an urban elementary school located in a southern state.

I am inviting your child to be a participant in my research study. The purpose of the research is to study the effect of instruction in math on student achievement. A second purpose is to determine what the difference is in the attitudes toward math of fifth grade students. Your child was selected because he/she is a fifth grade student and the researcher is your child's math instructor. Your child's identity will remain confidential. The study will take place at your child's school. The study will be conducted over a 9-week grading period. This will not affect the quality of learning your child will receive. Your child will not be penalized if you choose for your child not to be a participant. Your child may also withdraw from the study at any time without penalty.

Please review the parent consent form and you may contact me if you have any further questions at 325-2426.

Thank you,

Mrs. Gamble

Appendix D: Parent Consent Form

Your child is invited to take part in a research study on understanding the effect of instruction on student learning in math and attitudes towards math of fifth grade students. MAP scores will be used for making comparisons to the rest of the data. These scores will not be used for any other purposes outside this research project and your child's identity will be protected. Your child was chosen for the study because he/she is a fifth grade math student and attends the school that has implemented a newly developed math curriculum. This form is part of a process called "informed consent" to allow you to understand this study before deciding whether to allow your child to take part.

This study is being conducted by a researcher named Mrs. Valerie Gamble, who is a doctoral student at Walden University. The researcher is also your child's math teacher.

Background Information:
The purpose of this study is to determine if there is a difference in math achievement and attitudes on student learning of fifth grade students.

Procedures:
If you agree to allow your child to be in this study, your child will be asked to:

- Complete a survey at home – 15 min.

Voluntary Nature of the Study:
Your participation in this study is voluntary. This means that everyone will respect your decision of whether or not you want your child to be in the study. If you consent, the researchers will explain the study to your child and ask them if they want to take part. No one at the school will treat you or your child differently if you or your child decides not be in the study. If you decide to consent now, you or your child can still change your mind later. Any children who feel stressed during the study may stop at any time. They may also skip any parts they feel are too personal.

Risks and Benefits of Being in the Study:
There are minimal risks (such as feeling nervous or becoming stressed when answering questions) in being a participant in this study. Some students might feel nervous about questions asked because they may think that there are right and wrong responses. Some students might become stressed because they may not know how to respond to a question asked or do not have a response at all. This study will help understand the effect of instruction on student learning and attitude towards math.

Compensation:
There is no compensation for being a participant.

Confidentiality:
Any information your child provides will be kept confidential. Students' MAP scores will be used for making comparison to data collected. However, the researcher will not include your child's name on anything that could identify your child in any reports of this study. Your signature is not needed to protect your anonymity. If you wish for your child to participate, then

your child should answer the survey responses. If you do not want your child to participate then you do not respond.

Contacts and Questions:
You may ask any questions you have now. Or if you have questions later, you may contact the researcher via email or by phone. If you want to talk privately about your child's rights as a participant, you can call Dr. Leilani Endicott. She is the Walden University representative who can discuss this with you. Her phone number is 1-800-925-3368, extension 1210. Walden University's approval number for this study is **12-07-10-0302325** and it expires on November 30, 2011.

Appendix E: Assent Form for Participants Aged 7-17

Hello, my name is Mrs. Gamble and I am doing a research project to learn about the effect of instruction on student learning in math and attitudes toward math of fifth grade students. The purpose of this research project is to determine if there is a difference in math achievement and attitudes on student learning of fifth grade students. I am inviting you to join my project. I picked you for this project because you are a 5th grade math student. I am going to read this form with you. I want you to learn about the project before you decide if you want to be in it.

WHO I AM:
I am a student at Walden University. I am working on my doctoral degree. I am also going to be your math teacher.

ABOUT THE PROJECT:
If you agree to be in this project, you will be asked to:

- Complete a survey at home – 15 min.

IT'S YOUR CHOICE:
You don't have to be in this project if you don't want to. You won't get into trouble with me or the administrative team if you say no. If you decide now that you want to join the project, you can still change your mind later. If you want to skip some parts of the project, just tell me.

There are minimal risks (such as feeling nervous or becoming stressed when answering questions) in being a participant in this study. Some students might feel nervous about questions asked because they may think that there are right and wrong responses. Some students might become stressed because they may not know how to respond to a question asked or do not have a response at all. This project might help other schools by determining the effect instruction has on student achievement and attitudes toward math.

There is no compensation for being a participant in this research project.

PRIVACY:
Everything you tell me during this project will be kept private. That means that no one else will know your name or what answers you gave. The only time I have to tell someone is if I learn about something that could hurt you or someone else. Your signature is not needed to protect your anonymity. If you wish to participate, then you should answer the survey responses. If you do not want to participate then you do not respond.

ASKING QUESTIONS:
You can ask me any questions you may have. If you think of a question later, you or your parents can reach me at 325-2426. If you or your parents would like to ask my university a question, you can call Dr. Leilani Endicott. Her phone number is 1-800-925-3368, then dial 1210.

Appendix F: Researcher's Narrative

The researcher has been in the field of education for 20 years. During this time, the researcher has held several leadership roles, which includes, building manager, grade level representative, testing coordinator, and safety patrol advisor. For the past thirteen years, the researcher has been the director of the southern school's tutorial program, which runs for 2.5 hours at the conclusion of the school day with a focus on academic achievement. As director, the researcher works closely with staff, planning and designing effective ways that are beneficial to all students. Additional resources provided help students in math and language arts. The researcher oversees that the tutorial program is providing the needed services to students who qualify, and that teachers are working closely with those students helping them to achieve. The researcher is currently serving as a fifth grade teacher and has taught this grade level for 14 years.

Appendix G: Permission to use Survey

RE: Survey

Friday, October 8, 2010 4:17 PM

From:

"Tapia, Martha" <mtapia@berry.edu>

Add sender to Contacts

To:

"'valerie gamble'" <valeriegamble@bellsouth.net>

Dear Valerie,

You have permission to use the Attitudes Toward Mathematics Inventory (ATMI) in your study. If you have any question, please do not hesitate to ask me.

Sincerely,

Martha Tapia

Martha Tapia, Ph.D.

Associate Professor

Department of Mathematics and Computer Science

Berry College P.O. Box 495014 Mount. Berry, Georgia 30149-5014

Appendix H: IRB Approval

Walden University approval number to conduct research is 12-07-10-0302325.

Curriculum Vitae

Valerie D. Gamble

PROFESSIONAL PREPARATION

Doctor of Education; Specializing in Teacher Leadership
Expected Completion: July 2011
Walden University; Minneapolis, MN

Master of Education
Bowling Green State University; Bowling Green, OH
August 1992

Bachelor of Music
Ashland College; Ashland, OH
May 1983

CERTIFICATION

State of Ohio – Music Education and Elementary Education
State of South Carolina – Elementary Education

LEADERSHIP POSITIONS

Building Manager – Fairhome/Longfellow Elementary – 1994-1996
Safety Patrol Coordinator – Baker's Chapel Elementary – 1998-2000
Grade Level Chair – East North Street Academy – 2007-2008
Smart Center Director – 1998 – present
Teacher of the Year – Baker's Chapel Elementary – 2002-2003

SORORITY AFFILIATION

Alpha Kappa Alpha Sorority